The Engineer

VOL. CXC—No. 4946 | 28, ESSEX ST., STRAND, LONDON, W.C.2 | NOVEMBER 10, 1950

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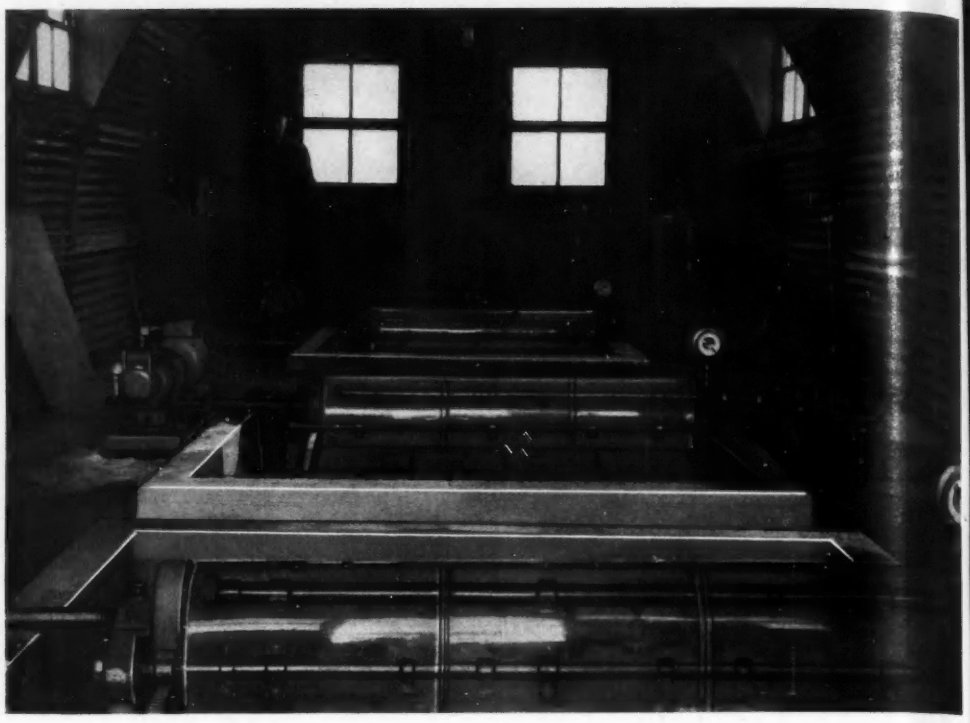

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The Future Demand for Chemical Engineers

A REPORT has now been issued by the Ministry of Labour and National Service on the present and future supply and demand for persons with professional qualifications in chemical engineering. Estimates of the committee which prepared the report show that in 1954 the total supply of chemical engineers from the universities will be double that of last year. Despite this increase in numbers the estimated available supply of chemical engineers for the next five years will not be sufficient to meet the specific demands brought to the committee's notice. It was felt that a more adequate supply of chemical engineers would in itself engender a demand for their services in new fields of employment to the advantage of British industry. Approval was expressed at the variety in the types of chemical engineering courses at universities and technical colleges, which fitted students for the needs of many industries. Strong chemical engineering departments should be built up in the universities as a matter of long-term policy, although the committee in recommending this drew attention to two reasons why such desirable expansion might be slowed down. Suitable teaching personnel was limited and the possibility of drawing good students into this field of study would only increase as the attractions of chemical engineering, both as an education and as a career, became more generally appreciated. The report recommends that consideration should be given without delay by the responsible authorities to the measures which could be taken to close the gap disclosed by the inquiry.

Port Operation and Maintenance

IN a paper entitled "Some Considerations Regarding the Allocation of Port Costs," read last week by Mr. W. M. Jenkins before the Merseyside and District Section of the Institute of Transport, the author expressed the view that the importance of transport in our national economy and the necessity of providing ports and dock equipment, called for a greater national interest in at least part of the burden of capital and maintenance costs. For shipping to enter and leave at all times, many natural difficulties had to be surmounted and they were a large item in the working expenses. The approach channels and the tidal range were the main factors influencing costs, and therefore the level of port dues. Regarding channels, Mr. Jenkins said that the fundamental causes governing tidal effects should be investigated under a national policy and the cost borne by the Treasury, and he pointed out that a big tidal range involved the building of a dock system at enormous capital cost. As an example of expenditure, Mr. Jenkins quoted £5,000,000 for the Port of Liverpool, and gave £400,000 as the annual servicing charges, which represented 6d. per ton on shipping dues. In the paper, the effect of remitting that amount was shown for a number of ships. Contending that the conservancy of ports was a public duty, Mr. Jenkins stated that money spent on such objects would be an investment paying good dividends. With Treasury funds defraying the cost of the necessary harbour works, exclusive of the normal facilities and services, resulting in a reduction in dues, Mr. Jenkins said that the effects would be far reaching, and he briefly reviewed the benefits as they affected port authorities, shipowners, traders and the community.

Mechanised Agriculture

A PARTICULARLY interesting paper, presenting a survey of power on the land, was read at a meeting of the Farmers' Club, in London, on Monday afternoon last by Mr. W. H. Cashmore, Director of the National Institute of Agricultural Engineering. Referring to the rapid progress in agricultural mechanisation in this country since 1939, Mr. Cashmore said that, even assuming a tractor to be equivalent to no more than four horses, the available power per acre now under cultivation appeared to be double that of pre-war. Such a high level of mechanisation, however, could only be justified economically if it resulted in a reduction in unit costs. Although, Mr. Cashmore continued, it was almost impossible to compare present farming costs with those before 1939, there were many instances where production costs had actually risen through the employment of machinery, but he claimed that its use was justified on the score of easier working conditions and on the fact that the necessary labour was not available. Mr. Cashmore thought that the change-over to mechanisation during the war years had been too rapid to allow careful planning either by the farmer or the implement manufacturers. He agreed that there was no lack of ingenuity in the design of farm machinery to-day, but, he pointed out, some effort seemed to be going into the production of machines and implements which could offer but small advantage to most farmers, and, furthermore, there was a real concern over the rising level of capital outlay on machinery. One of the most urgent needs at the present time, Mr. Cashmore asserted, was improved machinery to increase the performance per man-hour in the main processes, not with the object of reducing the total labour employed, but to enable men to be directed to the essential odd jobs on the farm which had been neglected in far too many instances.

Metallurgical Education

THE Joint Committee on Metallurgical Education, which was formed in 1945, has now issued recommendations on university full-time degree courses in metallurgy. This Committee was set up by the councils of the Iron and Steel Institute, the Institution of Mining and Metallurgy, the Institute of British Foundrymen, the Institute of Metals, and the Institution of Metallurgists for the purpose of advising the councils on all matters concerning metallurgical education. The Committee was asked to submit memoranda and recommendations, where considered appropriate, on matters within the general field of metallurgical education in the United Kingdom. During the past eighteen months the Committee has been engaged in the examination of that section of metallurgical education which is based on university and other full-time courses leading to internal and external degrees in metallurgy. In a booklet containing its recommendations following this examination, the Committee places particular emphasis on a number of points. It considers that university schools of metallurgy should ensure that entrants have attained a much higher standard of English than at present required. It is stressed that universities should make every effort to give a student his intermediate year's instruction inside the university and to avoid the admission of students at the end of the intermediate year. The instruction given during the first year of a four-year degree course should include some work in the humanities in addition to intermediate chemistry, physics and mathematics. No university, it is considered, should confer a degree in metallurgy without proof that the graduate can read technical literature in at least one foreign language. The brochure, which deals with these and other recommendations made by the Committee, can be obtained from the Secretary of the Committee at 4, Grosvenor Gardens, London, S.W.1.

A Joint Engineering Conference

AN announcement made this week gives some advance information about an engineering conference which is to be held in London, in connection with the Festival of Britain, from Monday, June 4, to Friday, June 15, 1951. The conference is being arranged by the Institutions of Civil, Mechanical and Electrical Engineers, and its aim is to place on record the contribution to civilisation made by engineers during the past 100 years, and also to provide an opportunity for discussing future trends in developing the great sources of power in nature for the use and convenience of man. The interdependence of all branches of engineering and the increasing co-operation of the members of the three major engineering institutions in this country will be emphasised at the conference, which will be open to members of the three institutions and to members of the institutions and societies participating in the Conference of Commonwealth Engineering Institutions or the Conference of the Engineering Societies of Western Europe and the U.S.A. The subjects to be discussed are road transport, sea transport, power, railways, aviation, education and training, the civil, mechanical and electrical engineering aspects being presented in separate papers; telecommunications, in which the civil and electrical engineering aspects will be presented; mining, in which the mechanical and electrical engineering aspects will be considered, and a miscellaneous group of subjects including water supply, sewage disposal, steelworks plant, gas industry plant, technique of electrical measurements, television, cable manufacture and electric lighting. The conference programme will also provide for a series of social events and visits to works and other places of interest. It may be added that the Institution of Mechanical Engineers does not propose to hold a summer meeting next year, the joint conference being regarded as a substitute.

Centenary of the Britannia Bridge

A WEEK ago to-day, on November 3rd, a plaque commemorating the centenary of the Britannia Bridge, which carries the railway from Chester across the Menai Straits to Anglesey and Holyhead, was unveiled by Colonel Trench, formerly Chief Engineer of the L.N.E.R. The bridge was built between 1845 and 1850, to the designs of Robert Stephenson, and was the first large bridge to be built as a tubular girder, the structural material being wrought iron. It consists of four spans, the two centre ones each being of 460ft, and the two side spans each of 230ft. Two lines of track are carried, each one by a separate tube, the side girders of each tube being spaced 15ft apart and the two tubes being 12ft apart within one external casing. Extensive experiments were carried out before the construction of the bridge to determine the relative strengths of wrought and cast iron. The superiority of wrought iron was clearly demonstrated by these tests, and the Conway Bridge, a single tubular span of 400ft, also across the Menai Straits, was then built by George Stephenson. The more ambitious Britannia Bridge was then designed on the same principle. The tubular girders of the side spans were built on false work, but the longer girders of the centre spans were floated out into position and lifted with hydraulic jacks. Finally, the girders were riveted together to make one continuous span. Colonel Trench remarked that the lateral sway of ¼in experienced in a high wind was not more than Stephenson provided for; less than £5 a year had been spent on maintaining the masonry and a dozen men could keep pace with the painting of both the Britannia and Conway bridges. The only change that had been made from Stephenson's detailed designs had been the laying of a heavier track to carry to-day's faster and heavier trains, the stress in the middle section not being materially increased by the weight of modern trains.

The Esquimalt and Nanaimo Railway

By EDWARD H. LIVESAY

No. I

EVERYBODY knows that the Canadian Pacific Railway spans the North American continent, starting at St. John, New Brunswick, on the Atlantic, and after making a tortuous way through British Columbia's mountain barriers finally reaches terminus and tidewater at Vancouver on the Pacific. This conception is correct as far as it goes, and is as far as common knowledge generally takes it; but it does not go quite far enough. As a matter of fact, the most westerly point reached by the C.P.R. is not Vancouver, on Burrard Inlet; it is not on the mainland at all. Vancouver is the terminus of the transcontinental line only; further, Burrard Inlet, on which it is situated, does not deploy into the open sea, but into the Strait of Georgia, upwards of 100 island-studded miles from the Pacific. The most westerly point reached by the C.P.R. is Port Alberni, on Vancouver Island, a busy little lumber town at the inner end of a narrow 20-mile long fjord, the Alberni Canal, and it is by means of this inlet that a vessel, after having loaded at Alberni, the westernmost Canadian railhead, finally emerges into the Pacific. "But that is the Esquimalt and Nanaimo Railway," may be objected by the critic. "Granted, and that is the C.P.R."

Before proceeding, one or two geographical and titular points will be the better for a little clarification, such as the distinction between Vancouver and Vancouver Island; their respective relation to British Columbia; the common affiliation of the three and how it all came about. There is sometimes confusion on these matters. First, location. Vancouver Island, of which it may well be said when comparing it with the rest of Canada:

> "This other Eden, demi paradise,
> This precious stone set in a silver sea
> Which serves it .... as a moat defensive to a house
> Against the envy of less happier lands,
> This blessed plot...."

lies off the coast of British Columbia, yet forms part of the province, much as the Isle of Wight, let us say, lies off, yet is part of, Britain. The uninformed often look for the City of Vancouver on Vancouver Island, but in vain; it is on the mainland. Why this confusion of epitaphs? I do not know, and agree it is unfortunate and should never have been so arranged. But there it is, and Islanders, after vainly kicking against the pricks, now make the best of the confusion, but are quick to point out the distinction between the two localities, particularly when the City of Vancouver gets some piece of creditable publicity that should belong to the island.

Next, Vancouver, though by far the largest city in the province (population 350,000), is not the capital, which is Victoria (population 100,000). Victoria, however, is not on the mainland, but lies at the southern tip of Vancouver Island. It is more than a little confusing at first; extending my previous simile, it is rather as though Ventnor were the capital of England with London merely the commercial capital; larger, but of less importance socially! This ambiguity arises from the fact that Victoria came into being over a century ago—in 1843, to be exact—long before Vancouver was thought of, so it is only natural that the former soon became the most important settlement in the province—which was not even called British Columbia at that time—and was chosen as the seat of Government, which distinction it retains. It was a mistake, I think, to christen the town that sprang up at the end of steel when the C.P.R. reached Burrard Inlet in the '80s with the name already bestowed on the island. However, so things came about and remain to this day. Vancouver, on the mainland, is the transcontinental terminus of the C.P.R., the author of its being, and apart from which in all probability it would never have existed. In a brief half-century it has expanded from a bush-surrounded shanty town on the shore of Burrard Inlet into a great and rapidly

FIG. 1—SOUTHERN VANCOUVER ISLAND

growing commercial, manufacturing, distributing and residential metropolis; a city assured of a great and prosperous future even by virtue alone of its railway facilities and location on one of the finest harbours in the world, ice-free and open the year round. Victoria, on the other hand, the capital of the province, remains governmental and residential rather than commercial, and in my opinion always will so remain; after all, the logical place for industry is at the end of the railroads spanning the continent, on the mainland, not on an island. Nevertheless, Victoria, perhaps for the very reason that it is on an island a little bit off the beaten track, has many attractions denied to its larger rival—social, scenic and climatic advantages, and, to some degree, perhaps sentimental, as being "a little bit of Old England," though goodness knows why as regards the actual city, but with some semblance of truth where one or two residential areas and bits of the surrounding country are concerned. These claims, whether fully justified or not, make Victoria pre-eminently a haven to which people come on retirement, wherein to live*

* And according to Vancouverites, wherein to die, for which they claim it is pre-eminently suitable, some even asserting that most residents of Victoria are half dead already. Exaggerated; for "most" read "some."—E.H.L.

in peace and quiet in their declining years. How different things would have been had the original plans for the location of the C.P.R. matured—that is, its Pacific terminus—and Seymour Narrows and the many islands and channels separating Vancouver Island from the mainland had been bridged, as was originally intended. Then the development of the two cities might well have been reversed. In any case, Victoria inevitably would have been far more eclectic—governmental, commercial, distributive, residential, all in one, with the additional and by no means negligible advantage of being nearer the open sea and not separated from it by many miles of island-studded channels apt to be fog-bound in winter. Victoria might have retained its position originally established as the province's chief city, and Vancouver, though assured of importance for the reasons already given, might never have gained the undisputed commercial leadership in the province it boasts to-day. But the Narrows were not bridged, and in all probability never will be. These "might-have-beens"—what heart-burnings they engendered, and even sometimes still do!

The history of Vancouver Island goes back several centuries, but its actual development only covers the last hundred years. Drake, circumnavigating the world, sighted it in 1579; after that we hear little or nothing about it until the Spaniards established themselves two centuries later at Nootka, on the west side of the island; in 1792 it was surrendered to Captain George Vancouver, R.N., and was given his name. But settlement did not begin until 1845, when the Hudson Bay Company established a fort on the east shore of what is now Victoria's inner harbour. It is the largest island on the west coast of North America; notwithstanding a very common local delusion, it is not "bigger than Britain," or anything approaching the latter in size. It is 280 miles long by 60 to 80 miles wide, with an area of 20,000 square miles; the combined area of England, Scotland and Wales approaches 90,000. Very mountainous, with the highest peak, Mount Victoria, over 7000ft, the west coast is rugged and broken, innumerable bays and inlets serrating the outline and running far inland. The island is battered by Pacific gales and seas that sweep unhindered clear from the Orient, moulding and scarring the west coast just as the coasts of Scotland and Norway have been riven and scarred by similar agencies with Atlantic origin. The climate, mild and quite unlike that of any other part of Canada, is somewhat similar to the British, and for much the same reason, the Japan Current taking on the duties of the Gulf Stream. Rainfall varies from a moderate 27in in Victoria—much the same as London's—to over 250in in north-west coastal districts. Again very British: is there not a rain gauge in the Lake District of England

that registers upwards of 300in annually?

Coal is found on the island at various places, and is or has been mined at Nanaimo, Ladysmith, Wellington, Cumberland, &c.; iron and copper, too, but these deposits have not been worked to any extent yet. Magnificent timber, great sawmills, extensive fisheries and canning plants, with agriculture at the southern end of the island—these are the basis of its prosperity; it is still capable of vast expansion, many possibilities being hardly scratched. Its potentialities are in inverse ratio to its population, which at present is only about 150,000, nearly all concentrated in the south-eastern part of the island, the remainder of which is practically virgin soil—mostly rock! Such is Vancouver Island; bearing in mind the crudity and climatic severity of so much the greater part of Canada, the southern end of the island, at any rate, fully justifies the eulogies bestowed upon it by its inhabitants, particularly those expatriates of British birth—including the writer—who are fond of it because it is in so many ways a counterpart of the land from which they are exiled in body, but not in spirit, the memory of which they keep green. If you, the reader, decide to leave the Motherland, consider Vancouver Island as a substitute; come there to die, if you must—according to Vancouver's jibe—but live there as long as possible first; that is the sensible thing to do. Verily, you might live in a worse place. But do not imagine it is climatically a Riviera or even a Scilly Isle; it can go to zero in winter, and 10in of rain can fall in one month in Victoria! In brief, as England was to Europe in the imagery of the Immortal Bard—"a precious stone set in a silver sea,"—so in the opinion of the writer is southern Vancouver Island to the rest of Canada. Such is the setting of the E. and N.R., with which we will now deal. Romance enters into its story, beginning with the lowly origin and upward striving of a Scottish miner who rose from poverty to plutocracy, and had so much to do with the construction of the line; politics concern it, provincial and federal, and when they come into the scheme of things in Canada—and they so often do—a very tangled skein indeed is apt to need unravelling sooner or later. This is true of nearly every major railway undertaking in the country; the E. and N.R. is no exception.

1. The cradle of Victoria, where in 1843, near the foot of what is now Fort Street, on Bastion Street, there was built a wooden fort or bastion as a rallying point against possible Indian attack.
2. Store Street station, E. and N.R.
3. Johnson Street bridge.
4. C.N.R. terminus and freight yard.
5. E. and N.R. shops and roundhouse.
6. Russells station, the original terminus.
7. C.P.R. wharves and shipping office.
8. C.P.R. Empress Hotel.
9. Parliament Building (Provincial).
10. Victoria machinery depot shipbuilding plant, at which several 10,000-ton freighters, &c., were built during the war. One was torpedoed just outside on its first voyage, but salvaged, the only vessel to be attacked, it is believed, in the immediate vicinity of the Island.
11. Outer wharf, berths for ocean vessels, [protected by breakwater (12) built] by the Sir John Jackson Company, 1912, protecting vessels from S.E. gales, but not from S.W., which sometimes prevent ships calling.
12. Breakwater.
13. Dock in which "Hood" and "Repulse" lay side by side in 1924, stated to be the only time during their round-the-world cruise that this was possible.
14. American Black Ball Line M.S. "Chinook" (Victoria-Seattle); ties up at 15.
16. Point Ellice bridge; before the building of the Johnson Street bridge the most direct road route to Esquimalt.
17. Strait of Georgia, steamer route to Vancouver.
18. Strait of Juan de Fuca, steamer route to Pacific.
19. C.P.R. "Triangle Route" Vessel from Vancouver

FIG. 2—CITY OF VICTORIA

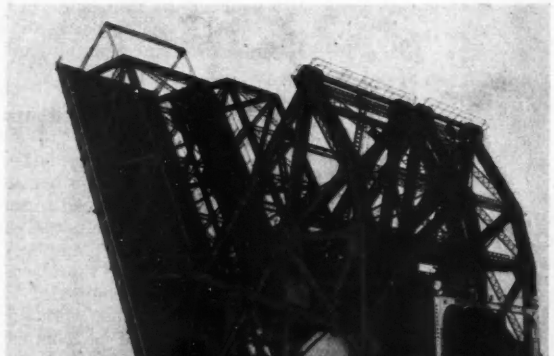
In 1866 Vancouver Island and the mainland, the latter then known as New Caledonia, joined hands to become British Columbia. From the beginning this great tract of sparsely settled country, separated from the older provinces to the east by the great Rocky Mountain barrier and in itself consisting largely of a trackless, unexplored wilderness of mountains, had grown up in isolation. Physically and politically it was a lone wolf, but now, claiming to have come to man's estate, the time seemed ripe for union with the rest of the country. Confederation became a burning question, and B.C., alike with the rest of Canada, was much concerned with the matter. The question was constantly coming up for discussion wherever two or three were gathered together, in public and private, in Press and Parliament. Should this far western outpost of civilisation, founded by pioneer descendants of the "Gentlemen Adventurers trading out of Hudson Bay," join in partnership with the other provinces to the east as a unit in the Federal State, or, according to some noisy malcontents from south of the 49th Parallel, would it not be better to cut the British-Canadian connection altogether and become part of the American Union? In the end wiser counsels prevailed; delegates were sent to Ottawa to negotiate British Columbia's admission to the Dominion, requesting—even stipulating—that provincial isolation should be banished by the construction of a wagon road through the mountains to the prairie and the east. To the delight of British Columbians a railway was offered instead, and the delegates returned full of optimism, convinced that the promises would be kept, that work would start at once, and the line be completed within two years. It was considered that the arrangements were in the nature of a treaty, the breaking of which was inconceivable. But Canadian politics came into the affair, and into the financial end of it as well, so nobody should have been surprised when the inconceivable occurred—the treaty was broken. Naturally, there was immense bitterness, with charges, by no means without justification, of lack of faith on the part of the Government. It was pointed out that an Order in Council had been passed in 1873 ordaining that the C.P.R. should be brought across Seymour Narrows to Vancouver Island, and that the terminus was to be Esquimalt, yet now it looked as if the pledges were going to be flatly violated. The following year the province protested to Queen Victoria about the continued delays in construction, and at the endless excuses and evasions. Further negotiations with the Government took place, leading only to more disputes, the Colonial Secretary, Lord Carnarvon, acting as arbitrator. Nevertheless, the deadlock continued; the agreement reached was turned down by the Senate, and indignation in British Columbia blazed up. Again there was talk of secession. "Carnarvon terms or separation!" was the cry, and the situation became so serious that the Earl of Dufferin, the Governor-General, came to British Columbia, with yet more promises and fair words—which suffered the same fate as their predecessors. Finally, the Order in Council was cancelled, and Burrard Inlet chosen as the terminus of the C.P.R., thus leaving the E. and N.R. plan "in the air," Ottawa even going so far as to condemn it as "a useless expenditure of public money." So things happened in the early '80s of the last century; Canada's pledged word had been deliberately broken, and the Queen's representative had condemned the plan for an island railway, though the Wellington

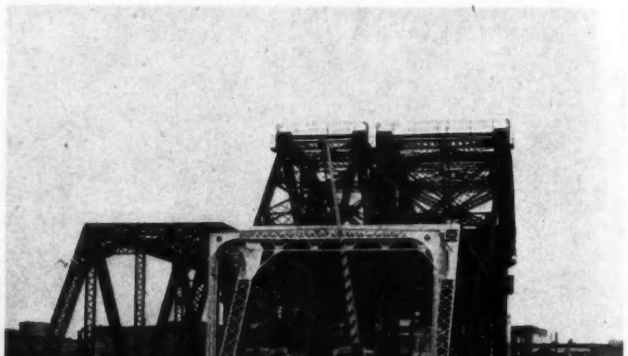
coal mines were dependent upon its construction for their very existence. It was all lamentable, and the future looked black; but here the Scottish miner, James Dunsmuir, took a hand in the matter, and the situation changed.

Dunsmuir was a courageous, energetic Scot, with imagination, initiative and perseverance. He had come to Vancouver Island thirty years before, working first as a miner at the coal face; discovering fresh deposits he interested capital, developed the seams and prospered. For many reasons he was determined to continue working the mines, not the least important being the fact that numerous people were dependent on them for their livelihood. Dunsmuir, already wealthy before the railway issue was decided—and whichever way it was decided—could have gone on making money with very little risk had he so desired; but the issue challenged him, and he decided to attempt what the Dominion had failed to achieve; he would build the railway himself as a separate enterprise, regardless of any connection either with the mainland or the transcontinental C.P.R. Moreover, engineers stated that the Malahat section of the proposed line—the part contiguous to Victoria, between Esquimalt and Duncan—was impossible; the grades would be too heavy and construction too costly. But Dunsmuir found a surveyor, Joseph Turner, who succeeded in plotting a feasible, though heavy, route, and Ottawa began to have stirrings of conscience—perhaps there was an election in the offing!—proffering 750,000 dollars, notwithstanding that only a year or so before the Government had condemned the whole plan as impracticable. British Columbia also gave monetary assistance, and other capitalists took heart of grace, including the American railroad magnates, Collis P. Huntington, Leland Stanford and Richard Crocker (all of whom were afterwards bought out by Dunsmuir, incidentally). Difficulties were overcome and the line was completed in 1886, twenty-three years after the first length of railroad on the island had been brought into operation for coal hauling at Wellington, which was in 1863. So much for James Dunsmuir, the Scottish miner-immigrant, whose courage and determination led to the completion of the E. and N.R., in the face of political and commercial strife and broken faith on the part of the Dominion that came near wrecking confederation.

The opening ceremony took place on August 13, 1886, Sir John A. Macdonald, the Premier, officiating; he was the man who had been chiefly instrumental in the building of the transcontinental C.P.R. and was at that time M.P. for Victoria in the Federal Parliament. The official party went to Esquimalt Station—now Russells—and boarded the train, which consisted of Dunsmuir's private car and a flat car headed by a 4–4–0 engine; the line had not then been carried across the harbour into Victoria. The run to Niagara Canyon, 15 miles, was done in 50 min, and a little later, after passing Arbutus Canyon, and reaching the summit, the train stopped at Cliffside, 25 miles from the present railhead in Victoria. Sir John and his party descended, and the last rail having been placed in position, he drove the golden spike home with a silver mallet,† amid cheers, hand-shaking, and mutual congratulations. Quoting the Victoria *Colonist*: "The party then boarded the cars, the train thundered down the grade, and soon the beautiful waters of Shawnigan Lake were seen stretching away to the north and west. A pretty scene was presented at Cowichan, where an arch had been thrown across the track, above which were grouped settlers with their wives and children, and Sisters of Charity with a number of bright-eyed orphans. The journey was continued to Nanaimo, where there were more speeches, Sir John predicting that the conjunction of coal and iron with ferry connection to the mainland and the C.P.R. at Vancouver would result in a great city. . . ." And so on—typical "boosterism" still common in Canada, but which in this instance had some possibility of taking concrete shape. The coal mines were worked and their output proved valuable; the iron has remained in the ground; the ferry certainly has matured, and the city—Nanaimo—if not "great," is at any rate a bustling, thriving community, still with a future. More about Nanaimo later. It was suggested that knighthood should be conferred upon Dunsmuir, but for some reason it never came about, though many a lesser man has been thus honoured. No monument has ever been erected to Dunsmuir, though a "flag" station on the line he built does bear his name. Only the railway itself and the great mansion "Hatley Park"‡ he built near Esquimalt remain witness to this outstanding Scot. Beyond any peradventure Dunsmuir left an indelible mark on Vancouver Island.

The first passenger train to travel over the new line left what is now Russells Station, in Victoria West, as it is called at present, on September 24th of the same year, with its destination Nanaimo, then the virtual end of steel. Two years later, 1888, the swing bridge over the Inner Harbour was completed, and on March 27th the first train ran into Victoria's Store Street Station, which is still the terminus. There were by this time 77 miles of track in use, from Victoria to Wellington, 5 miles north of Nanaimo, and no extensions were made until the C.P.R. took over the line from the Hon. James Dunsmuir—he had become Lieut.-Governor of B.C.—for 2,500,000 dollars in 1906. In 1911 the 39-mile branch from Parksville to Port Alberni was completed, and in 1914 the extension from Parksville to Courtenay came into operation; it had been intended to carry on to Campbell River, near Seymour Narrows, the site of the great dam and power station that has recently been brought into being there to distribute power all over the island. But the outbreak of the first World War stopped the project, which has never been consummated and, it is probable, never will be; a good motor road will be a sufficient substitute. Three further branches were built: (1) in 1913, to Lake Cowichan; (2) to Crofton, in 1924, and (3) from Port Alberni to Great Central Lake, in 1925. These are purely logging lines. When the E. and N.R. was opened four engines handled all traffic; the number increased to twenty-four in 1948, and the 77 miles of track to 211. Diesel locomotives are now ousting the steam locomotives, whose day is definitely over. It may be noted, and few even of Vancouver Island's residents are aware of the fact, that there are nineteen other railways in operation beside the E. and N.R., with a total mileage of 1151. Needless to say, most of them—probably all





FIGS. 3 AND 4—THE JOHNSON STREET BRIDGE

† Other accounts speak of a silver spike and wooden mallet—"you pays your money and takes your choice."

‡ It suffered the same fate as many another similar "Hatter's Castle" in Britain; none of his descendants could afford to live in it, and after millions had been spent on it, "Hatley Park" was bought during the war by the Government for 75,000 dollars, and has become a joint Army, Navy and Air Force Cadet training establishment.

—are dependent for their existence upon the logging industry.

The Victoria terminus of the railway is on Store Street, one of the oldest thoroughfares in the city, in what is now the wholesale district, but which was in early days the business section. This and the residential areas, especially the latter, have both moved far away; the aerial picture shows this area, as well as the station's location on the east side of the harbour, the track being carried over a bascule bridge (Figs. 3 to 5). It is a diminutive station, with only one platform, of four-car capacity, a longer train calling for the spotting of the additional cars on a siding and subsequent "marrying." The station, affected like so many Victorian establishments by war-engendered prosperity, has followed the fashion by having its face lifted, and an additional storey superimposed; it now comprises both station and executive offices the latter being on the new upper floor. The bascule bridge just outside the station carries both rail and road over the narrow neck of the Inner Harbour, the cramped nature of which is well brought out by the aerial photograph (Fig. 2). From this, too, it is evident why the Admiralty long years ago chose Esquimalt as the naval base, leaving the Victorian anchorage for commercial purposes to accommodate the small ships which at that time were all that sailed adjacent waters. So things remain to this day; nothing larger than the C.P.R. coastal vessels such as the fine new "Princesses" (Fig. 6) plying over the "Triangle Route"—Victoria–Vancouver–Seattle—can with safety use this "pocket-handkerchief harbour," as I bluntly dubbed it in a previous article. The photograph also shows the general lay-out of the city, the position of some of the chief establishments and points of interest about the water's edge.

The Johnson Street bascule bridge (Figs. 3, 4 and 5) takes the place of the original swing bridge built in 1888. Designed by the Strauss Bascule Bridge Company, of Chicago, it was opened in 1924, and is the most striking engineering feature on the E. and N.R. Constructed in two sections, for rail and road traffic respectively, it was built jointly by the City of Victoria and the C.P.R.; its chief dimensions will be found on the drawing, Fig. 5. It forms an important and time-saving link between Victoria and Esquimalt; previously road traffic had to take a very roundabout route via Point Ellice bridge (16, Fig. 2).

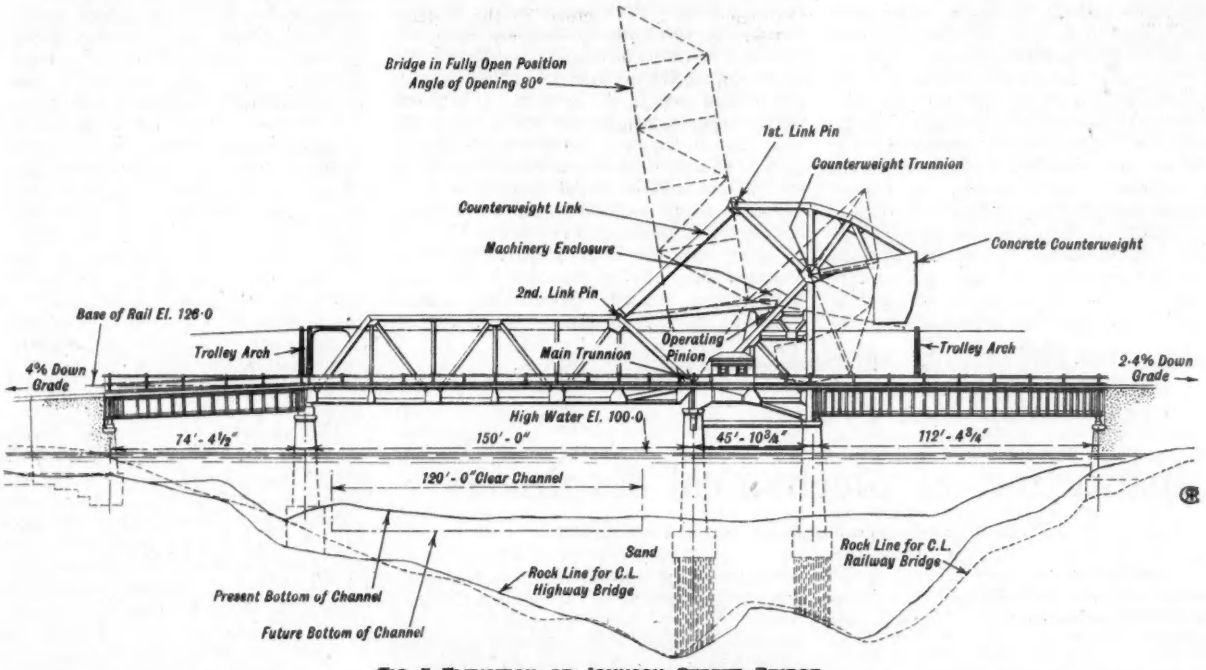


FIG. 5—ELEVATION OF JOHNSON STREET BRIDGE

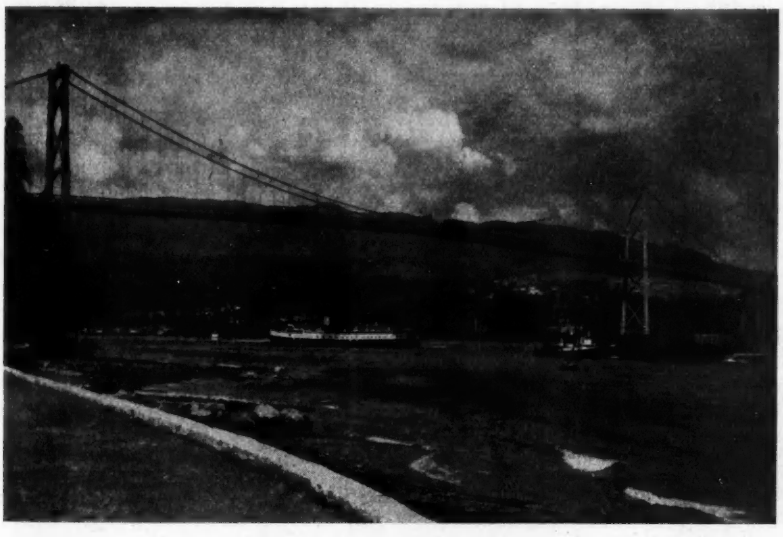


FIG. 6—"PRINCESS MARGUERITE" C.P.R.

"PRINCESS MARGUERITE"

Reference has been made to the "Triangle Route," and the steamers working over it; the services they maintain are such an intimate part of the transportation system of Victoria and Vancouver Island generally—it is practically a ferry service between the two cities—that a few words on the subject will not be out of place. The C.P.R. operates a daily service between the three cities of Victoria, Vancouver and Seattle by fast vessels leaving Vancouver and Seattle every morning and calling at Victoria *en route*. At night there is a shuttle service between Victoria and Vancouver all the year round, and between Vancouver and Seattle in summer. The vessels, invariably British-built, have always been fast and up-to-date, and the two new additions to the fleet, the "Princess Marguerite" and "Princess Patricia," which took up their duties this year—1949—will certainly uphold this high reputation. They are identical. Their tonnage is 6000, speed 23 knots, length 368ft, and beam 56ft; the "Marguerite" was built by the Fairfield Company, of Goven and she was handed over to the company on March 5, 1949. The propelling machinery is twin-screw, turbo-electric, h.p. 15,500, designed and built by the British Thomson-Houston Company. Each unit consists of a turbine driving at 3150 revolutions, a 3200V generator supplying current to a twenty-eight-pole synchronous motor developing full power at 225 r.p.m.

Steam is supplied by four oil-fired Fairfield-Johnson single-flow boilers working at 300 lb and 810 deg. Fah. All the auxiliary machinery is electrically driven, and steam for domestic purposes is provided by an

auxiliary single-ended Howden-Johnson boiler.

In day service the ship carries about 2000 passengers; sleeping accommodation is provided for ninety-eight in forty-eight cabins. The vessels are exceedingly comfortable; the amenities include dining and social halls on the upper deck, and convertible state rooms which can be used either as sitting or bedrooms, coffee and smoking bars, observation and ball rooms; sixty cars can be accommodated on the main deck amidships. Messrs. Waring and Gillow are responsible for the furnishing and decoration. In describing these vessels I am breaking my almost invariable rule of only dealing with what I have actually investigated; I have yet to sample these fine ships. But bearing in mind who built them and what company is operating them, it would probably be only gilding the lily if I set forth what I think of them, so the reader must take the company's word for it—that they are very fine vessels! He can safely do so.

Fig. 6 shows the "Princess Marguerite" passing out of Vancouver Harbour, under the Lion's Gate bridge, spanning the Narrows between Stanley Park and North Vancouver. The bridge was built by Guinness interests, the same investors having laid out large sums in developing the north shore of the harbour, in the area seen in the picture. It is a toll bridge, approached on the south by a fine road driven through the heart of Stanley Park. A radar station housed in the building seen in the middle of the span, is of great value in foggy weather, with which Vancouver is well acquainted in winter. I hasten to add, with my usual impartiality, that Victoria also is by no means free from this navigational hazard, though not cursed nearly to the same extent.

(To be continued)

Institution of Mechanical Engineers

No. II—*(Continued from Supplement, Page 6, November 3rd)*

THE concluding portion of Dr. S. F. Dorey's presidential address to the Institution of Mechanical Engineers is reproduced herewith:—

Strain Measurement

Static Strains.—In my experience no problem need remain long unsolved, no defect of operation unaccounted for, provided it is possible to make accurate measurements of the physical quantities involved, preferably under service conditions. This principle has been a guiding one during my professional life, and in the vibration field, has been expressed in the development and acquisition of the best available equipment, such as torsiographs, vibrographs, electromagnetic pickups, recording oscillographs, and sound measuring and analysing instruments.

It was therefore natural that when my attention was drawn to the wire-wound electrical-resistance strain gauge with its far-reaching, almost revolutionary, possibilities, I gave instructions for this new tool to be studied, developed and applied to its limit in the solution of our own problems. Initially our measurements were confined to static stresses, such as occur in pressure vessels, and our preoccupation was with details of technique. A good example of our early work in this field was the comparison of screwed-and-nutted versus welded boiler stays in terms of stresses in flat plate panels, such as are used for combustion chambers of Scotch boilers. These tests clearly showed that the welded stay could be at least as good as the conventional screwed-and-nutted type. Another stage was reached in the measurement of stresses in the welded longitudinal seam of the steam drum of a water-tube boiler. For this test the technique of complex-strain measurement was tried out, probably for the first time in Britain on such a large scale.[1]

Other applications in the static-stress field have included the measurement of stresses in the 9in thick walls of the hydraulic straining-cylinders of a lead-cable extrusion press; in the panels of a 70in diameter light-weight mild steel fabricated low-pressure piston for a triple-expansion marine steam engine; in mild steel fabricated steam-pipe branch pieces with welded reinforcing ribs, and quite recently in the upper and lower platens of a 2500-ton flanging press. A particularly interesting test was the determination of the effective launching effort acting on a ship when on the stocks, deduced from the strains in a compound-lever type of launching-trigger.

The object of these static tests has been, in the main, to provide data for new or improved designs, or to verify existing practice.

To illustrate the progress made in the sensitivity of strain gauge equipment, it may be stated that to-day we can rely on an accuracy of about ± 2 per cent and, under ideal conditions on the job, can detect strains of down to 1 micro-inch per inch, equivalent to a stress of 30 lb per square inch in steel.

Dynamic Strains.—Rapid as progress in static-stress measurements has been, developments in dynamic-stress recording have, if anything, proved even more remarkable.

In the marine application we have developed this type of equipment chiefly for the measurement and recording of torsional and bending strains in shafting. One of its earlier uses was to measure the torsional vibration strains in the test shaft of the large-scale fatigue machine previously described. For the relatively low-frequency vibrations met with in marine shafting systems and for the recording of shaft torques, it was soon found essential to design equipment which would give stable performance without distortion even down to zero frequency. This objective, coupled with the development of special slip-ring gear, has been successfully achieved by my research staff in the form of a high-frequency alternating-current-excited bridge, using strain gauges on the shaft for the four bridge arms. The low-frequency output is amplified and photographed in special multi-channel moving film cameras and gives a simultaneous record of steady and vibration stresses.

As random examples of the use of this technique, the following may be quoted:—

(*a*) The measurement of torsional vibration stresses in marine propeller shafting at sea.

(*b*) The determination of shaft horse-power for a paddle steamer at varying speeds up to about 50 r.p.m.

(*c*) The calibration of thrust meters and torsion meters.

(*d*) The recording of operating stresses in the side-rod top-end bolts of a Doxford opposed-piston heavy-oil engine.

(*e*) One of the most interesting applications so far projected is the recording of working stresses in propeller blades and tailshafts. The Society's Engineering Research Staff, in association with the well-known firm of propeller makers Messrs. J. Stone and Co., are now in the final stages of perfecting a special technique employing strain gauges. This development has been conceived and directed by one of my staff, Mr. T. W. Bunyan. The leads from the gauges are led away from the after end of the propeller boss, through an armoured flexible hose with curved steel protecting tube, to slip-rings and collector gear within the counter of the vessel. The usual a.c. carrier-wave technique is employed for strain indication and a permanent record is obtained by using a multi-channel photographic high-frequency recorder.

There is little doubt that the information we hope to derive from these tests will throw a good deal of light on propeller design and contribute, I hope, in no small measure, to a better understanding of propulsion problems, including such factors as aperture clearances in relation to blade vibrations and "singing" phenomena, and also blade stresses during torsional or axial vibration of the shafting. It is also expected to yield important data on shaft and blade stresses under conditions of partial screw immersion and when racing at sea.

Non-Marine Activities

At the time of my appointment to my present position at Lloyd's Register, the shipping industry was already in the doldrums and a further recession in shipbuilding was not difficult to foresee. There was thus a pressing incentive to extend the Society's activities beyond the marine field so that its technical resources could be utilised for the inspection of plant and materials intended for what we have come to call "non-marine" purposes.

This development had another and perhaps more important motive of greater significance to-day than ever before. I refer to the importance of maintaining liaison between land and marine engineers, so that marine engineering can reap early benefit from technical progress made elsewhere and, conversely, so that land engineers can profit from experience in the operation of plant under the onerous and variable conditions afloat. It is, of course, right and proper that new ideas should first be tried out on land, where adequate resources are available in the event of failure, before being applied in ships, which have to face the lonely hazards of the seas. It is therefore a wise thing for a ship classification authority to take an active interest in engineering as applied in the electrical, oil, chemical and other non-marine industries.

In the course of the years I have fostered this interest and considerable experience has been built up on engineering design and construction in many fields, particularly in the oil industry and in power plant. These, I feel, are healthy activities, which, whilst necessarily subordinate to our marine functions, ensure that the surveying staff is abreast of modern engineering practice and development. It is equally healthy that some of our great marine engineering firms have lately increased their interest in non-marine work and brought closer together these two great branches of mechanical

engineering, so fully represented in this Institution.

Conclusion

Looking back over the past twenty or so years, I cannot help feeling that I have been privileged to enjoy work as interesting and fascinating as any engineer could wish. It has brought me in contact with nearly all branches of mechanical engineering and taken me about Britain and into many parts of the world.

As would be expected, the emphasis of my responsibility has been upon the construction and maintenance of marine machinery and the business of ship classification in all its varied aspects of survey and approval in yard, workshop, steel works, foundry and forge, as well as in service. To this, particularly of recent years, has been added the technical interest arising from contact with many parallel problems in non-marine engineering, embracing such diverse subjects as refrigeration, power station plant, oil refineries and pipe-lines, railway electrification and, quite lately, welded construction of wind tunnels for aeronautical research. Nevertheless, it is in the sphere of what I might perhaps term "technical exploration," such as I have attempted to describe in this address, that I have, on the whole, found the most stimulating interest. In so far as this is successful in helping to explain or avoid machinery breakdown or in facilitating approval of new propositions or new materials or in formulating new rules to keep abreast of current engineering developments with due regard to safety, to that extent may it perhaps be said to yield its own satisfaction.

The variety and complexity of the problems encountered in the marine field in the course of developments during recent years will be apparent from my address. It has been my good fortune to grow up with some of them and be in a position to take many in my stride, but for the newcomer and younger engineer the range to-day is so wide that specialisation must inevitably arise for the majority.

The need for special selection and training of those required to occupy the higher executive positions, where breadth of experience and outlook is vital, will thus be apparent. The conservatism of which marine engineers are traditionally accused may, in some cases, have sprung from their avowed suspicion of the scientific approach. To-day this attitude, I am glad to say, is rarely encountered. Nevertheless, if we are to maintain our traditional leadership, science must have a controlling voice in the continued development of marine engineering. Progress in all branches of engineering requires a flexibility of approach to new ideas, which I have found more commonly fully developed in those possessing a scientific background to their practical engineering experience. The potential value and degree of reliability of new inventions and modifications to existing practice are also perhaps more easily assessed by those with this type of training.

These are some of the reasons why I have always endeavoured to foster the scientific outlook in the younger marine engineer. My aim has been expressed by encouragement to join the learned societies and technical institutions, to contribute technical papers and to take part in the discussions; by lectures to junior sections of societies and of the institutions, and by personal stimulation and advice wherever possible.

That we have men of determination, vision and ingenuity in the ranks of our marine engineers I am convinced and it is for those in the higher executive positions in the shipping industry to see that the best material is recognised, encouraged and fully matured in the national interest. Only thus can real progress in British marine engineering be worthily maintained.

Reference

[1] 1944 "Trans." Inst. N.A., Vol. 86, page 61, "The Use of Wirewound Electrical Resistance Strain Gauges, as Applied to Engineering Problems, for the Measurement of Static Strains."

The Public Works Exhibition

THE Public Works and Municipal Services Congress and Exhibition will be opened at Olympia, London, on Monday next, November 13th, and will remain open until Saturday, November 18th.

This congress and exhibition embraces for the first time two separate events, which were formerly held in alternate years, the Public Works, Roads and Transport Congress and Exhibition and the Public Health and Municipal Services Congress and Exhibition. It will cover the whole field of local government activities and preliminary information indicates that a thousand or more local authorities in Great Britain will be sending delegates. Under the auspices of a large number of institutions and associations a series of conferences will be held each day of the congress and papers covering a wide field of work will be presented by their authors. A majority of the papers have been printed and circulated in advance, and after they have been briefly introduced by their authors the time will be spent in discussion. During the conferences four prizewinning papers in a competition organised by the Congress Council will be presented.

Some 250 firms will be showing their products in the exhibition, and a very wide range of plant and equipment will be shown. The exhibits will include machinery for road and bridge construction and repair; vehicles and equipment for refuse disposal and cleansing purposes; and plant for building and constructional work, water supply, sewage purification, &c. These representative examples of the products of practically all the well-known makers of plant and equipment for large-scale public works contracting will provide an excellent opportunity for visitors to compare the principal features of the various designs. Much of the plant, although it will be familiar, incorporates new design details of interest.

Visitors to the exhibition will note with interest how the trend towards increased mobility of heavy plant continues to characterise the design of a majority of the large-capacity equipment, such as is used in road material preparation, constructional work, &c. Plant which, but a few years ago, had to be laboriously transported in large heavy units and erected on a carefully prepared site can now be arranged for transport by normal road haulage and prepared ready for work on a site in remarkably short times. This degree of mobility now makes it possible to keep a central mixing or preparation plant in close proximity to the working stages as a job progresses, and saves much time and labour in transporting prepared materials. Another point of interest is the remarkably small labour force which is now required to operate preparation and mixing plants of large capacity.

Blaw Knox, Ltd.

A representative range of contractors' equipment will be exhibited on the stand taken by Blaw Knox, Ltd., Clifton House, Euston Road, London, N.W.1, the central item of the display being a continuous loader, weighbatcher, concrete mixer and concrete pump arranged in line as for operation, using the latest high-speed methods of mixing and placing concrete. Most of the plant to be exhibited has already been described in these columns, but one item of interest is the firm's new "BK-Fifty" fully revolving excavator of ½ cubic yard capacity, which we illustrate on this page (Fig. 1).

This new machine has been designed for a wide range of duties and can be supplied with six interchangeable attachments: a drag

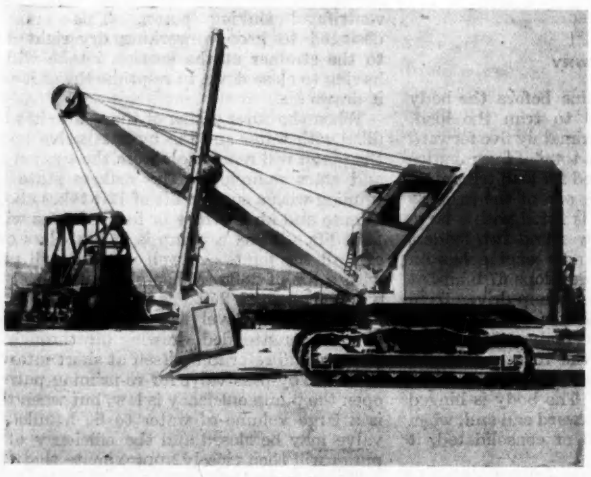


Fig. 1—Half-Cubic-Yard Excavator—Blaw Knox

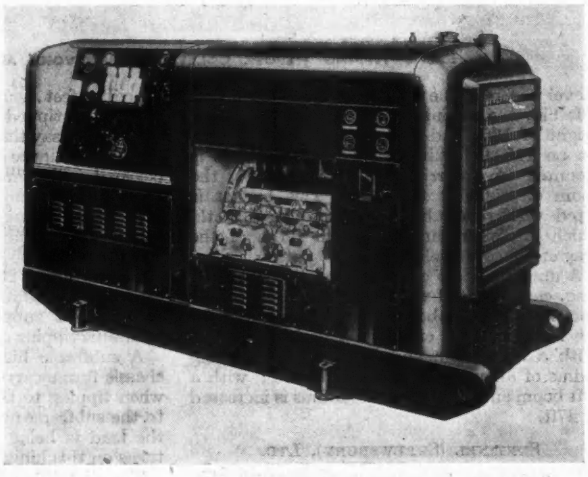


Fig. 2—Alternator Power Unit—Sentinel

shovel, face shovel, skimmer, dragline, grabbing crane, and crane, all of which can be quickly fitted or removed without need for changing the operating mechanism.

The unit is carried on a fabricated crawler frame fitted with self-cleaning shoes, each track being supported on seven well-proportioned bushed rollers. A tension control adjustment is fitted at the front of each crawler for shoe tensioning, and one at the rear is for adjustment of the driving chain tension. The turntable is welded to the fabricated lower frame and carries the slewing spur wheel.

The revolving frame is built up of electrically welded structural steel sections and is carried by four adjustable bronze-bushed load rollers which run on the top surface of the roller track. The two front load rollers are located immediately under the boom foot supports to avoid eccentric loading. Three stabilising rollers, the front one of which is adjustable, engage and run on the under surface of the roller track and prevent tilting of the revolving frame. A positive lock, controlled from the operator's cab, prevents accidental rotation of the revolving frame when travelling.

The hoisting cables wind on to large diameter grooved drums controlled by heavy-duty internal expanding clutches and external contracting brakes. Similar controls are fitted to the boom hoist drum, which is fitted with a safety pawl to prevent any possibility of the boom slipping. The winding drum and transmission shafts run on heavy-duty ball bearings.

The machine is driven by a Perkins "P.6" six-cylinder diesel engine developing 52 b.h.p. at 1500 r.p.m. on a twelve hour continuous rating. Power is transmitted through a 14in automotive type single-plate Borg and Beck clutch, a two-speed gearbox and heavy-duty roller chains. In low gear the excavator has a speed of 0·84 miles an hour and in top gear 3·4 miles an hour.

The drag shovel boom is 15ft 8½in between pin centres and carries a bucket arm 8ft 7in long. It is fitted with a 30in bucket as a standard, but optional buckets of 24in and 36in can be supplied. When fitted with a face shovel the machine has a dumping radius of 18ft 6in, a dumping height of 13ft, a cutting height of 19ft, and a clean-up radius of 14ft. On an 18ft 9in skimmer boom the bucket is mounted on a carriage which runs along the boom on eight steel rollers. This bucket is fitted with renewable manganese steel teeth, which are interchangeable with those of the drag and face shovels.

A dragline boom of lattice construction, 30ft long, can be fitted with a 5ft or a 10ft extension, and the same boom is used when adapting the machine as a crane or a grabbing crane. With a 30ft boom and 19ft depth a digging radius of about 34ft can be obtained; with a 40ft boom and 18ft depth the radius is increased to 47ft.

SENTINEL (SHREWSBURY), LTD.

In Fig. 2 we reproduce a photograph of a self-contained, semi-portable, industrial power plant, which will be shown amongst the power units on the stand of Sentinel (Shrewsbury), Ltd. This plant is driven by one of the firm's "4 SRH 2" diesel engines with a twelve-hour rating of 65 b.h.p. at 1500 r.p.m. It is designed to deliver a 3-phase, 50c/s, 400-230V output of 50kVA at 0·8 p.f. continuously and 55kVA at 0·8 p.f., for a period of one hour. The unit is mounted on a heavy skid frame and is totally enclosed by removable panels. A neatly arranged switchboard contains the grouped alternator controls and other instruments.

The four-cylinder engine has a bore of 4·75in by a stroke of 5·25in, and has the Ricardo "Comet" Mark III combustion system with a C.A.V. fuel pump and injectors. A rigid one-piece cylinder block is fitted with cast iron dry liners and the high-grade cast iron cylinder heads are made in pairs to facilitate dismantling. The valve gear is operated through a camshaft, cam levers, push rods and rocker levers, and the assembly includes a tappet screw which provides easy means of valve clearance adjustment.

The pressure lubrication system of the engine is fed by a gear pump driven from the camshaft and delivers oil at 45 lb per square inch to the main bearings, and at 10 lb per square inch to the camshaft and valve gear. A large-capacity radiator is fitted with detachable elements for water and lubricating oil.

SHELVOKE AND DREWRY, LTD.

A new rear-ground-loading fore-and-aft tipping refuse collector with a capacity of 16/18 cubic yards will be exhibited amongst the vehicles on the stand of Shelvoke and Drewry, Ltd., of Letchworth. This vehicle, illustrated in Fig. 3, has been developed to eliminate the necessity for manual load trimming. The body is arranged for rear loading over a rave of 4ft 8in loading height from ground level, and it can be tipped forwards into a vertical position for trimming and consolidating the load, and tipped backwards for discharging.

A deep hopper is provided below the rave and takes the contents of forty or fifty standard 3½ cubic feet household bins before the body has to be tipped forward to trim the load. The makers say that approximately five forward tips of one minute each, or a total of five minutes per load, is the time required for load trimming.

The body is mounted on one of the maker's "W" type chassis, which is fitted with a large cab to accommodate a driver and two loaders in comfort. The four-cylinder engine has an R.A.C. rating of 23·8 and develops 67 b.h.p. at 2800 r.p.m. A four-cylinder pump driven from the gearbox supplies fluid for the twin-ram hydraulic tipping gear of the body.

A subframe hinged to the rear end of the chassis frame carries the body and lifts with it when tipping to the rear. The body is hinged to the subframe near its forward end and, when the load is being trimmed or consolidated, it turns on this hinge.

The direction of tip is controlled by a hand lever, which controls a latch between the subframe and the chassis frame. When the subframe is locked to the chassis frame the body tips in the forward direction as the hydraulic gear is operated, and when unlocked from the chassis frame the same movement bolts the body to the subframe and the two tip to the rear as the hydraulic rams extend. The extreme angle is controlled by a simple automatic cut-out operating the hydraulic control valve.

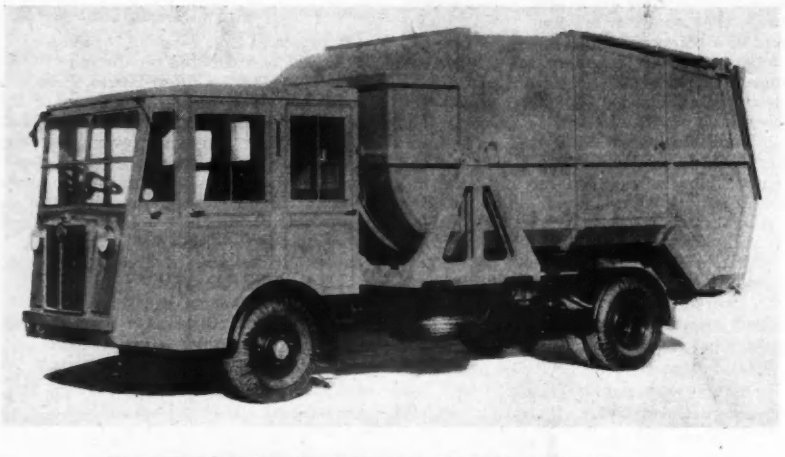


FIG. 3—TIPPING REFUSE COLLECTOR—SHELVOKE AND DREWRY

E. P. ALLAM AND CO., LTD.

A number of vibrators, vibrating tables and vibrating screens will be shown by E. P. Allam and Co., Ltd., of 49, Great Peter Street, London, S.W.1, together with other concrete consolidating and handling plant. This firm is now also making the useful portable bar cropping machine, illustrated in Fig. 4.

This cropping machine is hydraulically operated and can be supplied with an electric motor or a diesel engine drive. It is designed to crop bars up to 1¾in diameter in all sections.

The unit consists of a heavy frame having the power unit and pump at one end and a pair of jaws formed at the other end. The power unit drives the pump continuously and no action takes place until a bar is placed between the jaws. The outer jaw incorporates a heavy screw-operated anvil and the inner jaw is part of the hydraulic cylinder assembly. When a bar is pressed against the inner jaw it closes a valve in the hydraulic circuit and the ram advances to actuate the jaw and crop the bar against the fixed outer jaw. When the resistance of the bar against the inner movable jaw eases by reason of the parting of the bar the valve in the power circuit opens and the jaw is pushed back by a heavy spring ready for the next cutting cycle.

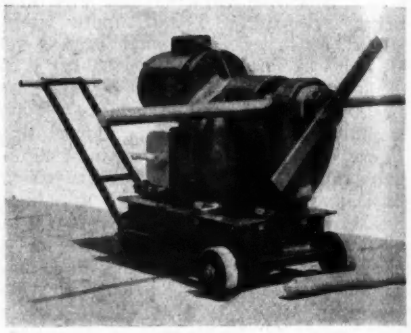


FIG. 4—BAR CROPPING MACHINE—ALLAM

The cropping unit is bolted on a substantial fabricated base mounted on two fixed front wheels and a swivelling rear axle controlled by a draw-bar.

HENRY SYKES, LTD.

A number of pumps particularly intended for use by civil engineering contractors will be exhibited on the stand taken by Henry Sykes, Ltd., of Southwark Street, London, S.E.1. Amongst these units is the firm's recently introduced vertically mounted, self-priming, centrifugal sinking pump. This pump is designed to keep a working dry right down to the strainer at the suction intake without having to close down to re-prime the unit when it draws air.

When the outer casing of the volute has been filled with water and the by-pass valve opened the pump will remove air from the suction pipe and start pumping. The makers state that priming with a suction lift of 12ft takes about a minute and about three or four minutes with a 25ft. lift. When a pump is in first-class order and all the joints are well made it will prime with a lift of 28ft. When the water level in a working of up to 25ft has been reduced to just above strainer level the pump will continue to work unattended, drawing air through the strainer and re-priming itself at short intervals. With the by-pass valve for re-priming purposes open the pump efficiency is low, but when there is a large volume of water to be handled the valve may be closed and the efficiency of the pump will then closely approximate that of an ordinary centrifugal unit.

The makers of the pump point out that the

design adopted has been evolved by trial and error to obtain the best results. It is thought that when a jet of water from the by-pass nozzle strikes the eye of the pump impeller and passes into the blades it entrains bubbles of air, which are carried through the impeller with the water. A large water space in the volute outer casing of the pump then gives comparatively calm conditions, which enables the air and water to separate, the water returning through the by-pass for re-circulation, and the air passing out through the delivery pipe.

These vertically mounted self-priming centrifugal pumps are made in three sizes with outputs from 4000 to 50,000 gallons per hour. Portable pumps of similar design are made by the firm for a wide range of outputs and with engine or electric motor drives.

STOTHERT AND PITT, LTD.

In addition to a selection of its well-known range of concrete mixers, Stothert and Pitt, Ltd., of Bath, is to show a 15-tons-per-hour mobile asphalt plant, in which all the motions are driven by separate electric motors; and a concrete vibrating, compacting and finishing machine fitted with a 14 h.p. diesel engine and set up for 10ft raft widths.

A particularly useful little machine on this stand will be the 6½-cwt power-propelled vibrating roller we illustrate in Fig. 5. This

FIG. 5—VIBRATING ROLLER—STOTHERT AND PITT

machine, which has one roll, 28in wide and 21in diameter, is guided by a pedestrian operator through hand grips and an adjustable belly pad secured to the end of a guiding handle, which can be adjusted in height to suit the operator.

A 2¾ h.p. air-cooled, four-stroke petrol engine provides the motive power for high-frequency vibration of the roll and traction. Power is transmitted to the vibrator through a friction clutch controlled by means of a hand lever attached to the end of the guiding handle and accessible to the operator while at his control position. The traction drive is taken through a totally enclosed gearbox containing reversing friction clutches, constant-mesh spur reduction and change-speed gears, and change-speed clutches, all running in oil. The machine has two forward and two reverse speeds of 57ft and 110ft. per minute, and the direction of travel can be instantly reversed from either direction of travel without shock. The reversing lever has three positions, the central one of which, being neutral, serves to stop the machine travelling.

MILLARS' MACHINERY, LTD.

One of the principal exhibits of Millars' Machinery Company, Ltd., of Bishops Stortford, Herts, will be a semi-portable dual-purpose plant for the production of all types of hot and cold asphalts, tarmacadam and bituminous macadam. This plant, which is completely self-contained and has a nominal capacity of 10 tons an hour, is fitted with a mechanical feeder unit. These feeder units can be supplied with either single or twin belts, on which two different aggregates can be fed in controlled predetermined proportions. In the plant, aggregates bitumen and filler are proportioned separately by weight.

The pumps on this firm's stand include a 3in "Carter" self-priming centrifugal unit, with a maximum capacity of 6700 gallons per hour at 15ft suction and 13,000 gallons at 5ft suction, and a 3in single-diaphragm pump for handling up to 5000 gallons an hour with an effective lift of up to 25ft.

GEORGE COHEN, SONS AND CO., LTD.

The wide range of contractors' tools and equipment which will be seen on the stand of George Cohen, Sons and Co., Ltd., will include three representative examples of the well-known "Jones KL" mobile cranes.

The largest of the cranes to be shown is powered by a diesel engine and has a capacity of 4 tons. It is fitted with a 25ft channel jib as standard, but alternative 30ft, 40ft and 50ft lattice jibs and certain special types of jibs can be supplied by the makers. The cranes can be mounted on road wheels, crawler tracks or rail wheels and a lorry mounting can be supplied, if required. An additional drum can be provided for operating the unit as a double-rope grab, and it can handle standard hook-on or ring discharge single-chain grabs. A 2-ton diesel-engine-driven crane on the stand will have a standard 16ft cantilever jib and can be fitted with a 24ft lattice and other special jibs.

In the two larger cranes full engine power is available for hoisting, full-circle slewing, travelling and derricking. The smallest of the three cranes, of 15 cwt capacity, has hand derricking. This small unit is driven by a 6 h.p. air-cooled petrol engine and its uses range from ship hoisting with a 16ft channel jib to straight lifting work with 20ft or 35ft tubular masts.

VICTOR PRODUCTS (WALLSEND), LTD.

Amongst the contractors' tools and equipment displayed by Victor Products (Wallsend), Ltd., of Wallsend-on-Tyne, will be a new electric hammer drill, designed for a wide range of application. This unit operates from single-phase supplies and working at full load has a power consumption of 600W.

The design and operation of the drill can be followed with reference to the photograph reproduced in Fig. 6 on this page. The armature

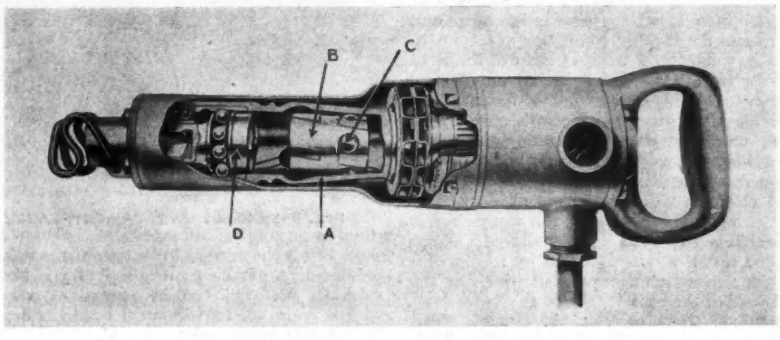


FIG. 6—ELECTRIC HAMMER DRILL—VICTOR

drives a cylindrical sleeve *A*, which has four spiral grooves formed in its bore. Within the sleeve is a reciprocating hammer *B*, slidably located on the sleeve by four large balls *C*. During operation the hammer rotates with the sleeve and the speed of rotation causes the balls to be thrown outwards to engage in the grooves and the hammer is driven down the sleeve. The head of the hammer strikes an anvil tool holder *D*, which has two inclined faces formed on its percussion head. As the hammer hits the anvil the anvil rotates due to its inclined faces and the blow causes a momentary halt in the rotation of the hammer. This halt allows the balls to drop back into the body of the hammer, which rebounds to its original position at the top of the sleeve ready for the next striking cycle.

The design of the anvil tool holder is such that only when the drill is actually doing work is the hammer allowed to contact the anvil, and although the sleeve rotates continuously no wear takes place and no work is done by the motor until drilling is to be done.

AVELING BARFORD, LTD.

Exhibited for the first time by Aveling Barford, Ltd., of Grantham, will be the British-built Aveling Austin "99-H" motor grader. This machine is similar in all respects to the American-built unit with four-wheel drive and four-wheel steering and full hydraulic controls. It is fitted with a Leyland six-cylinder, 100 b.h.p. oil engine and has six forward speeds, from 2·2 to 19·3 miles an hour.

A standard 13ft long blade fitted to the grader can be adjusted to cut from 1ft 9in below to 1ft 4in above ground level and moved to any banking angle up to the vertical on either the right or left-hand side of the machine. The blade can be extended up to 89in beyond the outside line of the rear tyres or to over 10ft when using the four-wheel steering to offset the rear wheels.

This firm will also show four road rollers of from 30 cwt to 12½ tons, together with one of its "Calfdozers," a trench cutting machine, and five dumpers in capacities from ½ to 9 cubic yards.

GOODWIN, BARSBY AND CO., LTD.

The plant shown by Goodwin, Barsby and Co., Ltd., of Leicester, will inclue the first two sections of its new "Goliath" mobile crushing and granulating plant, which is capable of producing up to 40 tons an hour of minus 1½in material and can be adjusted to crush to minus ¼in if required.

The complete plant is in three sections: primary, secondary, and screening and storage units, and each may be used separately or in any combination.

The primary unit deals with material from the quarry face, crushes it down to 2½in, if required, and delivers it by conveyor either to stockpiles or to one of the other units. The secondary crushing and screening section has a granulator, fine crushing roller-bearing rolls and a "Vitex" rejection and sizing screen. It can be fed by the primary section or, if used alone in a gravel pit, can be equipped with an automatic feeder.

Four folding conveyors can be used to distribute the product to stockpiles or, by use of a portable conveyor, additional screening can be obtained by connecting up to the screening and storage unit. The last unit, which will not be included in the exhibit, consists of a "Vitex" vibrating screen mounted over steel bins divided into four sections.

The outfit is provided with jack legs, which may be raised on site or lowered on to pneumatic-tyred wheels for transport purposes. Each section is provided with a diesel engine as a power unit, but electric motors can be included if required.

E. BOYDELL AND CO., LTD.

In addition to three dumpers of 6½, 4½ and 3 cubic yards capacity, E. Boydell and Co., Ltd., of Manchester, will exhibit for the first time its recently introduced "L.H.1." hydraulically operated loader. This machine (Fig. 7) is of unusually small construction and has been developed for high-speed operation in confined spaces. It is fitted with a bucket 42in

wide, which can be raised to a height of 8ft 9in to give a dump clearance of 5ft.

The loader can be fitted with either a 35 b.h.p. petrol engine or a diesel engine as required and can be driven at speeds up to 12 miles an hour. Power is transmitted through a gearbox giving two speeds forwards or reverse, a fully flexible propeller shaft, a worm reduction final drive, and fully floating axles. Steering is effected through a heavy-duty box and the machine has a turning circle of 15ft.

The bucket is raised and lowered by means of hydraulic jacks and the control gear has been arranged to permit straight or measured tipping.

The makers state that special buckets, fork-lift and bulldozer blade equipment has been developed for use on this new machine.

FIG. 7—HYDRAULICALLY OPERATED LOADER—BOYDELL

FIG. 8—PLANT TRANSPORTER—WINGET

WINGET, LTD.

The display of equipment arranged by Winget, Ltd., of Rochester, includes a number of concrete mixers, one of the "200" trenching machines, and the useful plant transporter illustrated in Fig. 8. This transporter has been introduced to provide a cheap and easy means for rapidly conveying plant up to 3 tons in weight and within platform limits of 10ft long by 5ft 7in wide. It has an all-steel body with a timber floor and is mounted on independently sprung road wheels fitted with 27in by 6in heavy-duty pneumatic tyres. The loading height is 14in and the fitting of double loading ramps enables plant to be wheeled on to the platform without the aid of a crane or other lifting tackle. One of the ramps forms a detachable tailboard when required. Plant is hauled up on to the platform by means of a 1-ton geared, manually operated winch at the towing end of the unit.

The mixer to be seen on the transporter is one of the firm's "7 T/H" hopper-fed tilting mixers. This improved machine has a high-angle, rapid-discharge hopper and a newly designed mixing drum.

EAGLE ENGINEERING COMPANY, LTD.

Only two machines are to be exhibited on the stand of the Eagle Engineering Company, Ltd., of Warwick, and the company's extensive range of refuse vehicles, tower wagons, &c., will be shown by a large number of photographs. The machines shown, a road gritting or sanding attachment and a road sweeper, are both units designed for towing behind a motor vehicle.

The sanding attachment, illustrated in Fig. 9, has a substantial steel frame and is mounted on pneumatic tyres. The hopper, which is fed by hand from the towing vehicle, has a 1½in square-mesh grid at the top and at the base is a worm conveyor driven by a roller chain from the nearside road wheel. This conveyor has a right and left-hand feed, which in, addition to breaking up lumps in the grit, feeds material towards the central point of a spinner below the hopper. An adjustable trap at the bottom of the hopper controls the amount of grit fed on to the spinner.

The spinner has a number of vanes radiating from its centre and is rotated by a fibre pulley on a countershaft which runs beneath the spinner disc. The shaft is driven by a chain from the offside wheel of the unit. The fibre pulley can be set at various positions along the counter-shaft to set the speed of rotation of the spinner independent of the road speed of the towing vehicle. Material can be spread at varying widths from 4ft to 15ft on a road surface by adjustment of the spinner speed.

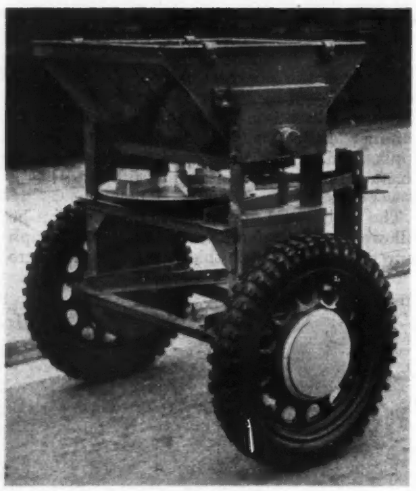


FIG. 9—SANDING ATTACHMENT—EAGLE

SOME OTHER EXHIBITORS

Among the equipment selected for exhibition by Frederick Parker, Ltd., of Leicester, will be a tarmacadam and asphalt plant and one of its "Portabin" elevating, screening and storage units of standard design. These units can be readily dismantled and mounted on pneumatic tyred road wheels for transport from site to site. Also to be shown by this firm are different types and sizes of rock and stone crushing equipment.

In addition to one of its well-known ⅝ cubic yard excavators and a mobile crane, Ransomes and Rapier, Ltd., of Ipswich, will show representative machines from its range of 5 to 28 cubic feet capacity concrete mixers and a model of the "RapieR" W150 walking dragline.

A recent addition to the universal excavators made by Ruston-Bucyrus, Ltd., Lincoln, is a unit of ¾ cubic yard capacity, which embodies certain improvements. It is driven by a new "4 YEN" oil engine with a rated capacity of 66 h.p. at 1200 r.p.m., and is mounted on a new type of track having round tumblers, which are said to give smoother travelling. A new design of controlled lowering type boom on this excavator enables the boom angle to be varied whilst the machine is travelling or when the load is being raised or lowered.

A "Bristol 20" angledozer to be exhibited by Montgomerie Reid Engineering Company, Ltd., Bramley, Basingstoke, is fitted with a 1 yard scraper attachment, which has been developed for work on small building sites. This attachment can be fitted to the tractor in a few minutes by a single pin and two hydraulic line couplings.

Together with examples of its range of air compressing plant Broom and Wade, Ltd., of High Wycombe, will exhibit a new roller chain hoist powered by the maker's eight-cylinder crankless air motor. Pneumatic tools for all classes of work will also be exhibited on this firm's stand.

Beilby Memorial Awards

IT is announced that consideration is to be given to the making of an award or awards from the Sir George Beilby Memorial Fund early in 1951. These awards are made to British investigators in science to mark appreciation of records of distinguished work. They are made at intervals determined by the administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals. In making the awards preference is given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. They are not made as the result of any competition, but in recognition of continuous work of exceptional merit bearing evidence of distinct advancement in science and practice. In general the awards are not applicable to workers of established repute, but are granted as an encouragement to younger men who have done original, independent work of exceptional merit over a period of years. The administrators can, if they think fit, make more than one award in a given year if work of sufficient merit by several candidates is brought to their notice. Three awards, each of one hundred guineas, were made in 1949, and we are informed that the administrators will be glad to have their attention drawn to outstanding work of the nature indicated not later than December 31st next. Communications on the subject should be addressed to the Governor of Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30, Russell Square, London, W.C.1.

HARD FACING.—Flexibox, Ltd., announces its new hard facing service for the application of "Stellite" or other exceptionally hard alloys to steel components.

Form Grinding

AT a General Meeting of the Institution of Mechanical Engineers, on Friday, October 27, 1950, a paper entitled "Form Grinding by Mechanical and Optical Methods," by E. A. Cooke, A.M.I.Mech.E., was presented by Mr. R. Pearson, Mr. Cooke being absent through illness. An abstract of the paper appears on page 443 of this issue.

Discussion

Mr. F. E. Robinson, who opened the discussion, said that his contribution to it would be largely of a historical nature. In the introduction to the paper there was a reference to the Royal Small Arms Establishment and the part which it played in the development of the precursor to the machine described, and it was stated that the Royal Small Arms Establishment suggested the adoption of generation as distinct from copying principles. That was not quite correct. At that time he was Superintendent of the Royal Small Arms Factory, and he was faced witn the problem of manufacturing a large number of gauges for the production of small arms. The only machines available, at least to some persons, were the Ludwig Loewe German machine and the Studer machine, which was of Swiss manufacture. The Ludwig Loewe machine had been illustrated that evening and employed a pantograph; the Studer machine employed a template. The disadvantage of the Loewe machine was the strain on the operator in constantly following a line and maintaining accuracy; the fault of the Studer machine was that if only one or two gauges were being made the cost of making the template vitiated any advantage obtained. About 1935, therefore, having had some association with Messrs. Taylor, Taylor and Hobson in connection with their profiling machines and die-sinking machines and their optical projector, he called on them and asked them whether they could develop a machine which combined the principles of the German and Swiss machines. Within a fortnight Messrs. Taylor, Taylor and Hobson came to him with an almost revolutionary idea, which was to dispense with the idea of a drawing or a template and to generate. They produced a drawing of the principle and a wooden model of the actual linkage which they proposed to employ. They were given carte blanche and after three years of very painstaking work they produced a machine which was installed in 1937 or 1938, and with one small exception proved entirely satisfactory. The only fault in the original machine was that the hydraulic head caused a certain amount of vibration. That was remedied by putting the hydraulic operating motor at a short distance from the machine and transmitting the power to the grinding head. The new machine was a development of the original machine, and, if it achieved what the original Taylor, Taylor and Hobson machine could do, it would be very successful.

Mr. R. Robertson said that a point which occurred to him related to the provision for avoiding trouble from the abrasive grit resulting from the grinding operation. He appreciated that the author had been chiefly concerned to make clear the type of construction and mechanism employed, but it would be interesting to have some remarks on what special precautions were taken to avoid dirt getting into the bearings and the very accurate slides of the machine.

Mr. Mark H. Taylor said that the paper traced the development of various profile grinding machines. All such machines were basically devices in which wheel or work was permitted to move in a plane, and usually in a horizontal plane, such movement being constrained by some device which assured that the relative movement of the wheel and work, either in steps or continuously, traced the desired shape. Since the finish and accuracy of the work required from such machines was generally high, it was felt in laying out the desirable features of the machines which had been described by Mr. Pearson—and he referred particularly to the earlier one, the large machine which embodied the pantograph—that the area within which grinding could take place must be large enough for all normal work to be ground without resetting. An area of 3in by 3in was chosen, which was very much larger than anything which could be done on any previous machine. It was also felt that wherever possible step-by-step location must be avoided and replaced by a continuous sweeping of the wheel over the work, thus generating the desired form. This could be done in the case of straight lines and arcs and other forms, for which suitable linkages could be devised. In designing the earlier machine, it was thought desirable to mount the work-table within a pantograph having a ratio of 5/1. Even with this small ratio it would be clear that the so-called copy table had to be free to move over an area 15in by 15in, and that was where the troubles began. Minute errors in pantographs had most elusive consequences. Even after providing fine adjustments to the axes of the linkages the problem still remained that the links were subject to varying stresses, both bending and torsional, as the links were opened and closed. Whatever adjustment was right for one position was wrong for another. It was also by no means easy with this construction to avoid backlash, and cyclic and other errors in constraining the work and copy tables to rotate in unison. It was therefore after considerable experience that the Genoptic machine was designed, in which all the rotating elements were mounted in one main casting, where tapes were substituted for gears, and where no attempt was made to employ any mechanical form of magnification or reduction. In the Genoptic machine all magnification was done optically and the ingenious means described in the paper were provided for superimposing the images of several graticules, which in the machine itself were in different planes, on one screen. Since it was unnecessary in this last machine to see more than a small part of the work at any one time, adequate magnification could be employed without the necessity for a very large viewing screen.

Mr. P. Grodzinski (Associate Member) said that for trueing the grinding wheel a special optical device had been developed. Not much was said in the paper about it and some information on this subject would be of interest.

Mr. H. F. Plant said he understood that the photographic copy, which was used as a master, was produced to the same size as the actual workpiece to be ground. His organisation had carried out a good deal of experimental work with the object of finding out the distortion in a photographic copy, and had not found that it was possible to get a finer accuracy than 0·0002in to 0·0003in when producing a 1/1 copy from a 100-times master. That was an important point in relation to the accuracy of the machine.

The Chairman (Mr. J. M. Newton) said that the development of mechanical design was replacing to some extent the cylinders, cones and flat surfaces which characterised the mechanical manufacture of past generations by forms of more complex types, and at the base of producing those must be the provision of accurate gauges. He looked with very great respect on a machine in which the accuracy of repetition was of the order of 0·0001in or less. How was such accuracy to be obtained? He suggested in two main ways. First of all the machine should appear to be accurate; in other words, in design it should use those shapes which lent themselves to accurate production and it should avoid those shapes which were difficult to produce. The machine described in the paper passed that test very well indeed. For example, to get exact synchronism of rotation between the three turntables, steel bands were used in place of gearwheels, which would produce at best a ripple of 0·0001in to 0·0002in, as well as introducing troubles from backlash. Another example was the avoidance of the use of keys, which always tended to produce eccentricity. It would be interesting if the author would give more particulars of the method used to transmit torque. Another example was the fact that since temperature differences in a machine were a frequent source of inaccuracy there was a double shield round the lamp supplying light for the optical system. He gave those as examples, which impressed him as showing that the design was satisfactory. Beyond the design was something which could not be seen, and that was the accuracy of manufacture in the workshop in which it was made. It was not possible in any ordinary workshop to get, by order, an accuracy of 0·0001in; it must be the result of years of patient work, following a policy of improving continuously the fundamental measurements of length, the straight edges, surfaces and joints used in the machine. That could be found only by experience—experience of the kind of products which the makers of the machine in question produced. This country led in the development of machine tools, in the sense that they originated here, a century and a half to a century ago, out of the genius of such engineers as Maudslay, Nasmyth, Roberts and Whitworth. Did we still lead? He suggested that the paper showed a lively sense of invention and enterprise in this matter.

In the state which this country was in, a sudden call for an increase in armaments might call for a lot of gauges. There would be hundreds of people wanting them, and this machine would walk away with them on price, compared with traditional methods; admittedly it might not save on a single gauge, because although it might produce the article more quickly the cost of the machine might more than balance the saving. Further, he doubted whether cost was the only consideration because, if the demand for gauges increased suddenly, it would not be possible to create toolmakers suddenly and it was possible to get a series of gauges off the machine more quickly. He suggested, therefore, that there was a very real field for a machine of the kind in question. He had merely taken as an example the kind of thing which was being produced to-day, but all experience would be falsified if, when a new machine was introduced, new

uses were not found for it, of which nothing was known at the moment. It would be found that the engineer, or even the operator in charge of such a machine, as new problems cropped up would find that it could solve them.

Mr. R. Pearson replied shortly to the discussion and the meeting closed.

A Review of Road Problems*

By W. H. GLANVILLE, C.B.E., D.Sc. (Eng.), Ph.D.

No. I

SEVENTEEN years ago the subject of roads was dealt with comprehensively by the late Sir Henry Maybury in his Presidential Address.† His address, when read with his James Forrest Lecture on "Roads and Road Transport,"‡ delivered in 1929, provides a history of British roads from the earliest days and tells a fascinating tale of the formative years of the modern road system, in which he himself, as an engineer with administrative skill and drive, had played so conspicuous a part. For a variety of reasons the ensuing period has relatively far less to show in new construction than promised at that time. Despite the growth in traffic, the outlines of the main road system have remained unaltered, except for some few hundred miles of new construction. But if progress in the actual construction of new roads has been slow, the period has seen many important changes in the technique of road and traffic engineering. The period has been characterised, too, by a ferment of ideas often not yet sufficiently developed to pass into the region of practical application but significant in relation to future needs.

Materials and Methods of Construction

I will begin with the subject of the materials and methods used in road building. This subject has been given far more attention than any other, both by practising engineers and by research workers; for every year about £60,000,000 is spent solely on keeping existing roads in running order, and the value obtained from this large outlay depends almost entirely upon the suitability and durability of the materials and upon the methods employed in road maintenance. It is to be expected, therefore, that substantial progress can be recorded.

In respect of the quality of road surfaces, I think the ordinary car driver would be amazed if he could compare, side by side, the typical main road of twenty years ago with its counterpart of to-day. He would notice particularly the great improvement in the resistance to skidding in wet weather, and the greatly improved riding quality. Since then slippery road surfacings have been gradually replaced by non-skid varieties. There is to-day, in fact, no technical reason why any road surface should be slippery. Remarkable improvements have been made in the riding quality of road surfaces, particularly since the war. New types of machinery have contributed much to this improvement and progress has also been helped by the development of rapid methods of measuring surface irregularities, and, therefore, of comparing different roads. The night-time motorist of twenty years ago had to find his way without "cats-eye" studs and with very few white lines to guide him. The plastic white line developed to make good a wartime shortage of paint has come to stay. In the towns, standards of lighting have been laid down and fluorescent lighting is being introduced to give the motorist better street lighting.

The ordinary car driver knows little and cares less about what is beneath the running surface, but the engineer knows that just as much thought and care must go into the building of the foundations of a road as into the surface. In 1933, knowledge of soils and their behaviour had yet to be established, and the intervening period has seen great activity in research into the subject of soil mechanics. Soils have been classified according to physical properties of interest to the engineer. The effects of moisture and clay-content and the laws of the movement of moisture have been studied in detail. Knowledge of how to compact soils, of the properties of the compacted material, and of the comparative value of the various techniques of compacting, enable the engineer, using modern equipment, to construct embankments that can be used immediately without waiting long periods for settlement. The development of electrical methods of drainage has provided the engineer with a new means of dealing with subsoil water. A better understanding of the bearing values of soils and of the effect of weather upon them enables road crusts to be designed with more certainty and economy. The use of soil stabilisation as a practical and economical process has been fully established and even soils containing considerable quantities of clay can now be stabilised.

Co-operative research between industry and government, involving extensive full-scale experiment, has contributed to a great improvement in the materials and techniques employed in the surface-dressing of roads. In the early 'thirties flying stones and tar frequently heralded in the surface-dressing season. This annual phenomenon has now disappeared: a life of five years is now fairly common and much annoyance and several millions of pounds a year are saved to the nation. The effect of weather upon bituminous surfacings is now largely understood as a result of research into the oxidation, evaporation and hardening of the bituminous binder. The "black magic" of bituminous materials has yielded to scientific examination and the properties of binders and the compositions of surfacings required to give long life are now fairly well known. A great deal of attention has been paid to the use of local aggregates and binders, for, although it appears that almost any type of material can be used, the conditions vary with the materials and must be carefully determined for each type.

Owing to the small mileage of new road construction the technique of the concrete road has been hard put to it to attain the standards in running surface set by the machine-laid bituminous surfacing. But with the development of prestressed concrete and the use of special cements and aggregates it is possible that the dream of the ideal jointless concrete road may yet come true. In the meantime, many improvements have been made in methods of making joints.

As often happens in such situations, the advances that have been made in the past twenty years in our mastery of road materials have revealed new problems. The control that it is now possible to exercise over the physical characteristics of these materials is in itself a challenge to the engineer to produce a standard surface, which can be used throughout our road system, or at least on our main roads. We are gradually building up information on the desirable properties of texture, tone and colour and, within limits, it is possible to define these properties quantitatively. But the economic need to use local materials renders complete uniformity impracticable.

Traffic Trends and Road Expenditure

The progress I have been able to record in the improvement of materials and methods of construction is not, in my view, matched by developments in the technique of road planning and design, nor for that matter, in the actual task of providing a national road system comparable with the needs of a huge national industry. Despite all the difficulties of recent years this must remain a matter for astonishment when one reflects upon the size of the road transport industry and its supreme importance in the economic life of a small, compact country such as Britain, with its many industrial centres, between which the easy flow of essential components and goods of all kinds is a vital factor in determining costs.

The services provided by road transport cost the country about a thousand million pounds a year and, according to official statistics, about one and a quarter million persons are engaged in making, repairing, servicing and driving the vehicles used and in maintaining the road system. This figure does not include the many hundreds of thousands employed in other industries, for example, tradesmen who also drive vans and cars for business purposes. Making some allowance for these, but including nothing for those who drive to their work, it is probable that road transportation absorbs about 8–10 per cent of our industrial potential, as against about 3 per cent by the railways. The number of vehicles on the roads—a matter of a few thousand at the beginning of the century—has, in the course of the past two decades, shown some interesting fluctuations. In his Presidential Address Sir Henry Maybury reported about 2,200,000 vehicles for the fiscal year 1932–33. In 1938 the vehicle population passed the 3,000,000 mark. By 1943 it had fallen to 1,500,000, but it rose again to 3,100,000 in 1946. But the most remarkable fact is that by 1949 it had risen to about 4,000,000 vehicles—with a total horsepower potential roughly ten times that produced by the British Electricity Authority.

In fact, each of the three decades—the 'twenties, the 'thirties, and the 'forties—saw a rise of one million in the number of vehicles registered and it is even more remarkable that the number of goods vehicles has increased by 70 per cent since 1939. All this despite the slump and the aftermath of two world wars, petrol rationing, the export drive, and the high price of vehicles and petrol. Will the same rapid rise continue, or, if not, what will happen? What would happen, indeed, with an industry showing such extraordinary powers of recovery, if all these deterrents were removed?

It is safe to say that no private industrial undertaking experiencing such a phenomenal expansion of business would fail so drastically to make proper provision for its growth. That this situation has arisen in road transport is due to a great many complex causes, among which must be counted the fact of

* Presidential Address, Institution of Civil Engineers, November 7th. Abstracts.

† Min. "Proc." Instn. Civ. Engrs., Vol. 237 (Session 1933–34, Part I), page 2.

‡ *Ibid.*, Vol. 228 (Session 1928–29, Part II), page 285.

administrative separation between the road user and the road provider—a state of affairs which is not experienced to the same extent by other systems of transport; but I feel that this has been due in a large measure to a failure to forecast the extent of growth of road transport. Even now, with the lessons of the past behind us, there is a risk, almost amounting to a certainty, that we may fail in this respect again; I should like, therefore, to devote a few minutes to considering this problem.

Nowadays, with machinery for a planned economy already partly in operation, the forecasting of road traffic trends should take account of official policies and shifts of policy. I do not propose to enter that controversial field—partly because I do not want to risk antagonising my good friends in the British Transport Commission and partly because I firmly believe that in a planned economy, as in an unplanned one, the best policy in the long run is to give the public what it wants—even if in so doing some cherished theories are jettisoned.

So far as I know, forecasts of the number of vehicles have always proved wrong. The prophets have generally predicted that the rate of increase would soon slow down and stop. It was argued in authoritative circles in the 'thirties that as there were only about 2½ million people with incomes of about £250 a year or more, some of whom would not want cars, the number of private cars would stop rising at the 2 million mark. But before the war the 2 million line was passed and registrations were increasing by 150,000 a year—faster than ever. The number of car registrations is now again increasing at a little below that rate. If it again attains the immediately pre-war rate we may well have 3½ million private cars on the road by 1960 and 5 million by 1970, and the corresponding total numbers of vehicles might even be as high as 6½ million and 9 million respectively.

The expenditure on road construction and maintenance has fallen steadily until, to-day, it represents, so far as I can estimate, a little more than a halfpenny per vehicle-mile. Excluding any allowance for drivers' time and one or two minor items, the cost per vehicle-mile of operating the nation's road vehicles is roughly made up as follows:

	Per cent
Road construction and maintenance	11
Fuel (1949 prices, excluding tax)	13
Accidents	13
Vehicle maintenance and depreciation...	63

The value of drivers' time and one or two other minor items have not been included in these figures, because they are very difficult to estimate, although they are undoubtedly large in total.

The figures show that the amount spent on road construction and maintenance is even lower than the cost of accidents or the cost of fuel. The average cost per head of the population is roughly thirty shillings a year, or about one penny a day. For that sum of money the individual has the use of the vast network of the roads of the country. It can hardly be disputed that the civil engineer is providing truly amazing value for the limited money that he is allowed to spend.

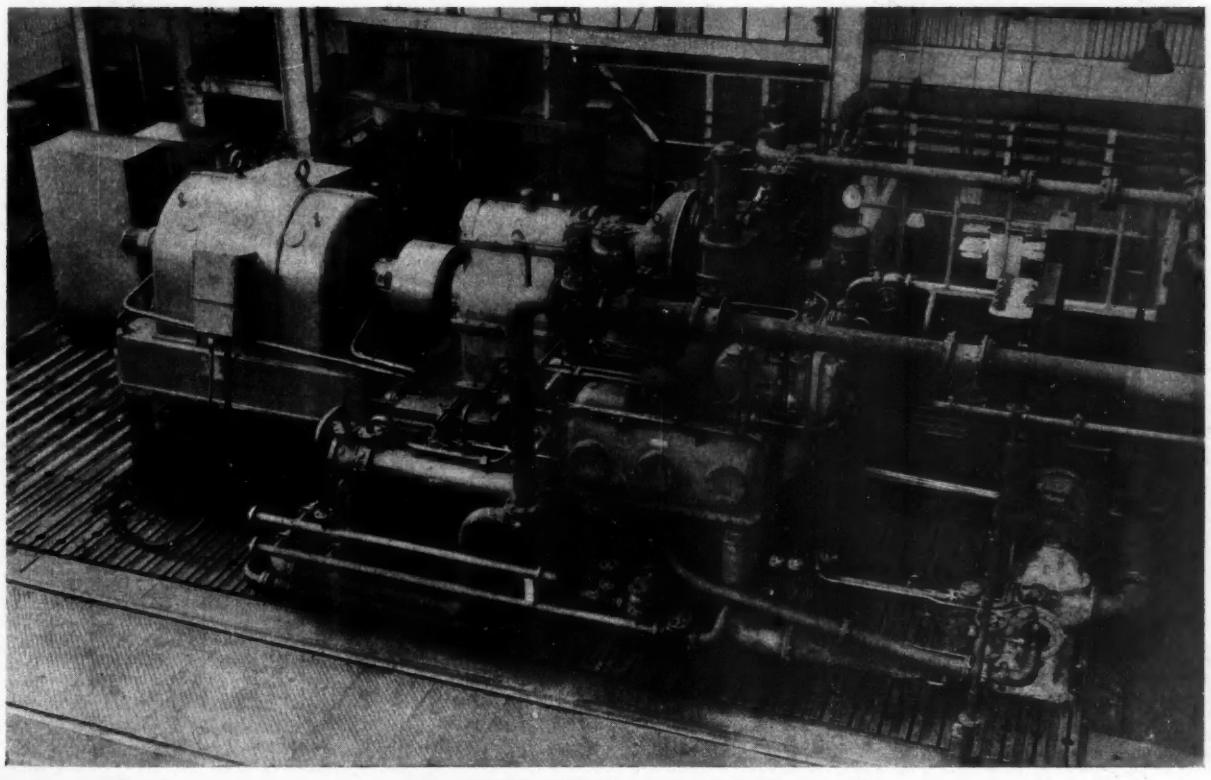
(To be continued)

Turbo-Alternator for a North Thames Gasworks

RISING costs and the increasing need for conserving the national resources have emphasised the necessity for effecting economies in all industries. In the gas industry the high price of coal makes it essential to abstract the maximum of power from the available waste heat. In many gasworks the auxiliaries are driven by single-stage turbines exhausting to the atmosphere, the efficiency of the arrangement not being especially considered because of the availability of large quantities of steam generated by waste heat. A more effective method is to make use of all the steam in turbo-alternators to run in parallel with the grid and then any excess power, after supplying that necessary to operate electrically driven auxiliaries, can be sold to the Electricity Authority, so improving the economy of the gasworks and making a contribution towards meeting the electrical load.

To satisfy the unusual conditions obtaining at a gas plant W. H. Allen, Sons and Co., Ltd., in association with Humphreys and Glasgow, Ltd., and Lancashire Dynamo and Crypto, Ltd., have built a 1390kW turbo-alternator for installation at the Beckton works of the North Thames Gas Board, and last week we were able to witness a demonstration of the plant at the invitation of W. H. Allen, Sons and Co., Ltd., and its associates.

The turbo-alternator, which is illustrated on this page, is designed to operate in conjunction with a water gas producing plant which generates gas in the normal manner by blowing air through a hot coke bed before the steam run. The waste heat generated during the air blow is used to raise steam in waste heat boilers at 290 lb per square inch gauge to drive the pass-out turbo-alternator, which provides low-pressure steam, at 15 lb per square inch gauge, to supplement other sources in the steam run. Process steam required is less than the amount of high-pressure steam generated, so a condenser has been fitted. A cycle of one minute air blow and two minutes steam run is involved with each gas making unit, and the four units installed will be staggered in operation so that the time cycle may be reduced to one-quarter, depending upon the amount of plant in use. A diagrammatic lay-out of the plant is given



TURBO-ALTERNATOR ON TEST IN MAKER'S WORKS

in the accompanying line drawing, which includes particulars of steam flow.

The arrangement raised unusual control problems. Power output for instance must be divorced from the electrical load and arranged to ensure the supply of low-pressure make-up steam for maintaining gas production, and make available high-pressure steam at any time. In a multiple water gas installation the control must provide for a cyclical fluctuation in quantity, quality and pressure of the steam and also variation in steam production and demand, which depends upon the number of units in operation, the quality of gas produced, and the grade of fuel used. Maximum reliability and the minimum of skilled attention are essential factors, so that to meet the many contingencies several automatic devices have been incorporated.

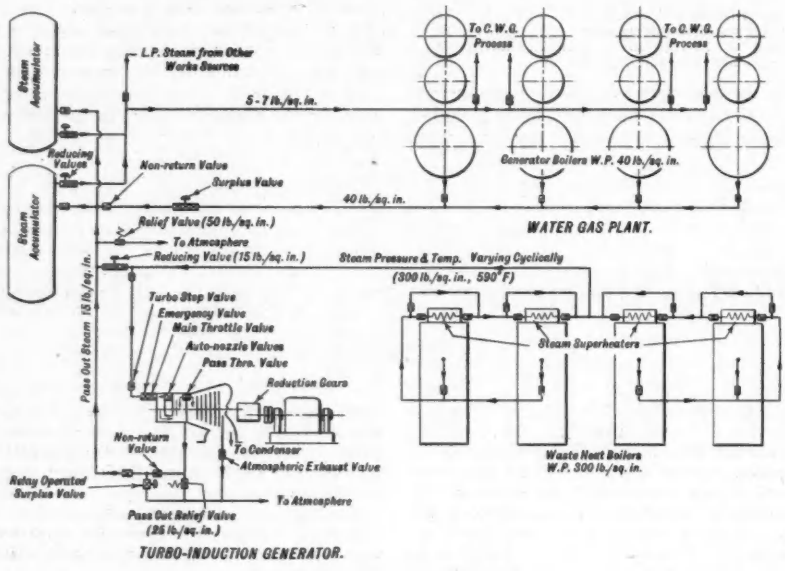
The works load exceeds the output of the turbo-alternator, so that one of the objections to an induction alternator,—that it cannot generate unless connected to the external supply—does not apply. Accordingly an induction alternator was chosen by the North Thames Gas Board. Compared with a synchronous alternator the induction machine does not need an exciter, commutators or slip rings; it is more robust due to its squirrel-cage rotor and can be paralleled in more easily.

Manufactured by Lancashire Dynamo and Crypto, Ltd., and rated for 1390kW continuous maximum rating at 1514 r.p.m. and generating 6·6kV with full load power factor of 0·93 leading, the totally enclosed induction generator has a closed air circuit with a Heenan and Froude water-cooled air cooler mounted below the alternator. An impeller at each end of the alternator shaft circulates the air and emergency dampers are provided against failure of the air cooler.

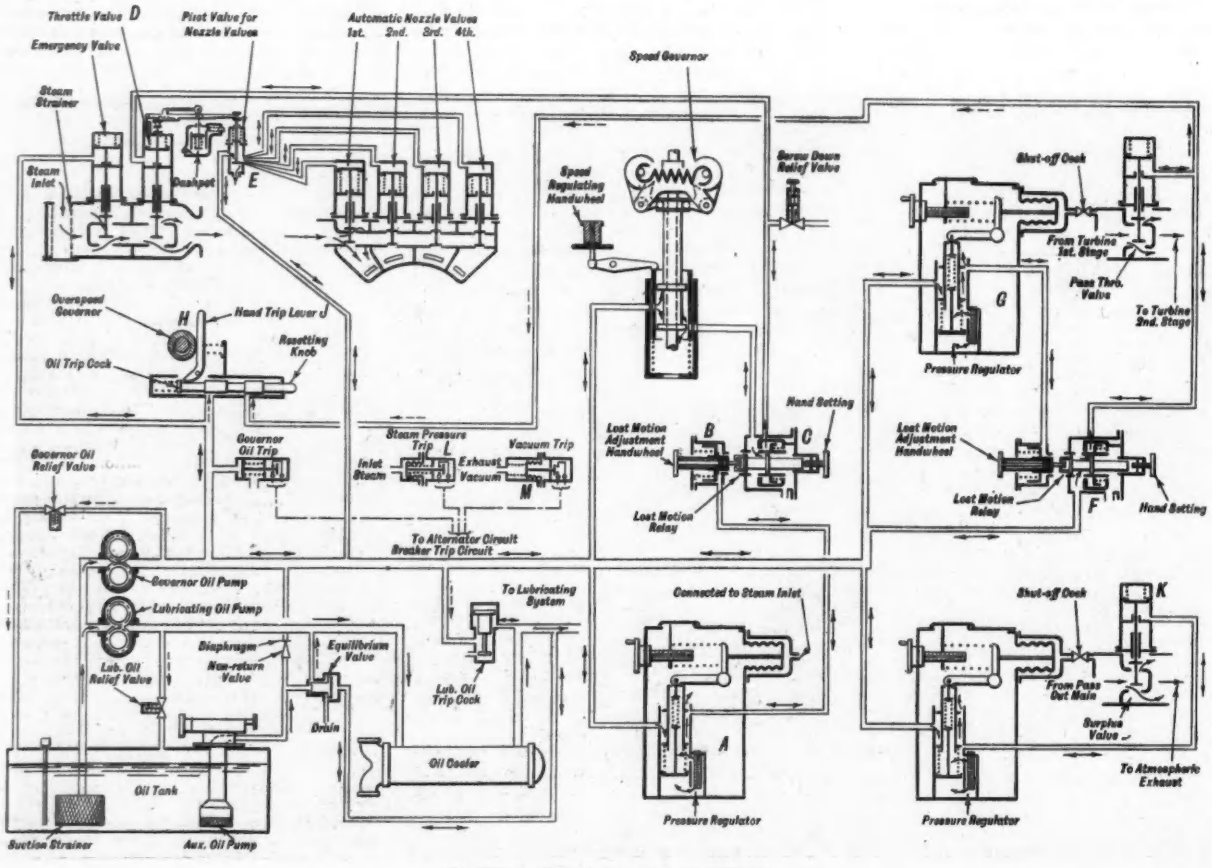
Running at 6000 r.p.m., the impulse turbine has two rows of velocity compounded high-pressure blading, upstream of the pass-out point, and then seven low-pressure compounded rows exhausting to a condenser. Designed on vortex principles, the blading in the low-pressure section has a continuous change of blade angle from root to tip, which allows for change in steam pressure due to centrifugal action and results in improved efficiency. Machined from solid bar, the blading is of low-carbon stainless steel, except for the last two rows, which are of high-tensile austenitic stainless steel. High-duty cast iron interstage diaphragms have low-carbon stainless steel vanes. The solid steel forged rotor runs well below the first critical speed and so allows minimum gland clearances, resulting in steam economy, which is further increased by sealing the low-pressure gland with steam bled from the high-pressure gland, any excess steam being led to an intermediate stage. Cast steel is used for the high-pressure section of the turbine cylinder and high-duty cast iron for the low-pressure end, while the main nozzles are of stainless steel.

Cyclical steaming conditions cause the boiler steam temperature to vary from that of saturation at 410 deg. Fah. (280 lb per square inch) to 650 deg. Fah. with a possible maximum of 700 deg. Fah. Although the turbine is designed for a steam temperature of 590 deg. Fah. it can withstand rapid temperature changes and the erosive action of wet steam. The double helical gearing has a ratio of 6000 to 1514, is hobbed and shared and designed to transmit a 50 per cent overload, and the flexible coupling of Wellman Bibby pattern, between the gearing and the alternator, is similarly proportioned.

Acting as the turbine base plate, the regenerative surface condenser is designed for a



STEAM FLOW DIAGRAM



CONTROL GEAR AND OIL SYSTEMS

vacuum of 28in (barometer 30in) when condensing 11,600 lb of steam per hour with cooling water at 80 deg. Fah. Mounted on a common base plate are the two-stage steam jet ejector air pump, which is equipped with surface heaters to recover the latent heat in the steam, and the circulating water and extraction pumps, which are tandem driven by a 40 h.p. totally enclosed squirrel-cage induction motor of gasworks pattern.

Governor Gear

With the set running in parallel electrically with a large-capacity supply, the use of a normal speed governor was precluded and it was arranged to control the inlet of steam by the pressure in the waste heat boilers, a fall in steam pressure closing the turbine control valves. This arrangement maintains a constant boiler pressure, which in association with automatic nozzle control valves ensures that the maximum heat drop is fully utilised and maintains maximum efficiency in the turbine under all loading conditions.

To avoid unnecessary movement of the governor gear and large fluctuations of the electrical load a lost motion relay is fitted, which prevents the inlet steam control valves operating under cyclical pressure variations, only a sensible alteration in gas making load moving the gear. This device, by allowing the waste heat boiler pressure to fluctuate slightly, makes the boiler a steam accumulator and the steam being drawn off at a constant rate means that the pass-out rate will also be practically constant. The cyclical demand for process steam will not synchronise with waste heat production and to meet the difference between supply and demand Ruths steam accumulators have been installed. Pass-out pressure and that within the accumulators will fluctuate cyclically and a lost motion relay is embodied in the pass-out regulating gear to make the pass-through valve unresponsive to these variations in pressure.

The accompanying drawing, showing the diagrammatic arrangement of the gear, indicates that a pump supplies lubricating oil at 10 lb to 15 lb per square inch and another delivers oil at 50 lb to 60 lb per square inch for governor operation. High-pressure oil is supplied to the steam inlet regulator pilot valve *A* and then to a lost motion relay *B*, the piston of which is allowed to float, by an amount equivalent to a pressure variation of 7 lb per square inch, before operating an associated pilot valve *C*. Full pressure of governor oil is available at the lost motion relay pilot valve, the oil from which controls the turbine main throttle valve *D* and through it the automatic nozzle control valves *E*. The piston of the lost motion relay *F* linked with the pass-out pressure regulator *G* floats by an amount equivalent to a pressure variation of ¾ lb per square inch. The set will run in parallel with a supply of 50 cycles per second frequency, but at a maximum frequency of 52 cycles the no-load speed of the alternator will be 1560 r.p.m., rising to 1574 r.p.m. at full load due to negative slip of the induction machine. At 1600 r.p.m. the speed governor will begin to override the inlet pressure regulator and progressively close the turbine steam inlet valves until at 1670 r.p.m. all steam, except ventilating steam, is cut off. Should the electrical link be broken the speed governor acts as a pre-emergency governor by preventing the shutting down of the turbine except in an emergency. A conventional unbalanced ring pattern emergency overspeed governor *H* releases governor oil pressure to close the main emergency stop valve and this trip *J* can be hand operated.

Safeguards

To prevent the set being motored by the alternator after the turbine has been shut down by the operation of the emergency trip, an electrical trip switch trips the alternator circuit breaker upon failure of governor oil pressure. In addition a lubricating oil trip cock is arranged to trip out the set upon failure of the lubricating oil supply. Maximum steam production from waste heat boilers is 26,000 lb per hour and normal pass-out steam demand is 10,800 lb per hour, leaving 15,200 lb per hour of steam to flow through the low-pressure turbine. Reduction in demand for pass-out steam would raise the steam pressure and proportionally increase the low-pressure steam flow, resulting in the output of the set rising above the maximum continuous rating and imposing an electrical overload on the alternator. To avoid this there is fitted in the pass-out connection a finely controlled surplus valve *K*, which releases pass-out steam to the atmosphere when the pass-out pressure reaches 16 lb per square inch gauge and is fully open at 17 lb per square inch gauge.

Failure of the steam supply or the occurrence of pressure low enough for the inlet pressure regulator to close all main control valves would cause the alternator to motor the turbine and result in overheating of the turbine due to windage. Against this eventuality a Maclaren steam pressure trip switch *L* has been provided, which will close contact when the pressure falls below a set point and trip the alternator circuit breaker. The contacts do not close at the same instant as the control valves, so provision is made for a small amount of ventilating steam, to bypass the control valves, to cover working conditions. Should the main stop valve be closed with the set running normally, the trip will protect the turbine. A similar device has been fitted to trip out the alternator should the vacuum fail, and the trip *M*, which guards against failure of the air pump, will give back-up protection against the closing of the main stop valve, with the set running, as the leak-off pattern gland sealing would be put out of action with consequent loss of vacuum. It is occasionally necessary to clear water, by venting, from the pipe to the vacuum gauge and vacuum trip switch. This action will operate the vacuum trip and switch out the alternator, and to prevent this a push button near the vent cock temporarily disconnects the trip circuit.

Starting and Paralleling

The full-load speed of the high-efficiency alternator is 1 per cent above synchronous speed, and to avoid shocks to the gears and flexible coupling the speed of the set is brought up to 1 per cent above synchronous speed before switching in, so avoiding the unstable ranges of the speed/torque characteristic of the induction motor. Because a turbine tachometer is not sufficiently accurate and cannot allow for an 8 per cent busbar frequency variation, and as the induction alternator cannot generate until connected to an external supply, an electrical tachometer, having a generator driven from the main alternator shaft, is employed for speed adjustment before paralleling.

Calibrated in terms of frequency, the tachometer element indicates a frequency of 50 cycles at 1500 r.p.m. alternator speed, and a separate frequency meter element, energised from the station busbars, has a main pointer indicating busbar frequency and a second pointer 1 per cent above it. Magnetising currents, of the order of twelve times full-load current, are avoided by inserting a current limiting reactor, when the machine is switched in, which must be short circuited before loading the alternator, so that starting procedure is complicated by the switching of the reactor. The maximum restraining torque of the alternator is one-half of full-load torque with the reactor in circuit and about two and one-half times when running normally with the reactor short circuited. In view of this, full steam must not be admitted to the turbine until the reactor has been short circuited, otherwise the stability of the alternator is one-fifth of normal pull-out torque and the alternator would be overcome by the turbine.

With the speed governor locked the machine is run up to speed and paralleled in on the main steam bypass valve, which passes little more than no-load steam. The small amount of steam means that the pressure in the steam chest will be insufficient to operate the impulse connection to the steam pressure trip and open its contacts, thus making it impossible to close the main circuit breaker, so that a delayed action push button has been provided. Mainly fitted because it is a requirement that the set shall be started up by one operator, this push button will cut out the trip current for about one minute to allow sufficient time for switching in the set.

To repeat, the starting procedure is briefly as follows. Start the turbine on the main steam bypass valve and adjust speed to 1 per cent above synchronous speed by means of the double-element frequency indicator; then put the steam pressure trip temporarily out of action by operating the delayed action push button and follow up by closing the main circuit breaker closing switch. With the reactor in circuit the alternator is switched in and then the reactor shorting switch is closed, while the speed of the set is maintained within the prescribed limits. Electrical interlocks ensure that should the main circuit breaker be tripped the reactor shorting switch will open and control panel lights will show whether the main circuit breaker is closed, while a warning light signals when the reactor is in circuit. At this stage the inlet pressure regulator is put into action and the steam stop valve opened, when the set will generate immediately. Finally, by operating the pass-out equipment and opening the pass-out valve steam is admitted to the accumulators in readiness for the water gas process.

At the works, site conditions were copied as nearly as possible, starting drill was carried out and all various safety devices were operated during a series of twelve demonstrations. Marked instrument panels were conveniently placed so that it was possible to watch events by reference to the gauges, meters and oscillographs and to note the response of each particular safeguard as all the expected contingencies were simulated.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

CYCLE THREADS

No. 811 : 1950. This standard was first issued in 1938 and was then limited to the standardisation of the form and basic dimensions of the thread. The present edition reproduces the former thread form and basic dimensions unaltered, and has been prepared to include tables of limits and tolerances.

The form of thread was first formulated by the Cycle Engineers' Institute in 1902 to provide a thread of suitable design and mechanical strength for the bolts, nuts, nipples, spokes and other threaded parts of cycles and motor-cycles. In 1933 the British Cycle and Motor Cycle Manufacturers' and Traders' Union approached the British Standards Institution for the recognition of this thread as a British Standard.

The first edition of the British Standard did not, however, attempt to include all of the many pitches and diameters which had been or were then in use. The C.E.I. thread system would appear to have been peculiar in that, as originally developed, it included a series of threads applicable to any size of stock, rather than organised and progressive sizes, and in practice this had resulted in a considerable diversity of diameters and associated pitches. Since there appeared to be no justification for this complexity, the British Standard, in its first edition, standardised only a selection of the more commonly used sizes. These sizes have since become established as the threads in regular use in the cycle and motor cycle industries, and they are perpetuated in this second edition.

The first edition of this standard included, in deference to usage at that time, a 20 t.p.i. series as an alternative to the normal series for bolts and nuts and similar applications, but the continuance of that series was not recommended. In the present edition, this 20 t.p.i. series is omitted from the tables of threads having the form of the cycle thread, but in view of the use in the cycle industry of a 20 t.p.i. series with a Whitworth form of thread the appropriate dimensions are given in an appendix.

The new edition includes complete tables of tolerances for the cycle threads for bolts and nuts, and also for special applications, such as those related to steering columns, hubs and sprockets and bracket cups. The tolerances for spokes and nipples are, however, still the subject of consideration by the B.S.I. Technical Committee in consultation with the British Cycle and Motor Cycle Manufacturers' and Traders' Union. For spokes and nipples the basic dimensions only are included in the present edition and an addendum will be issued immediately a decision has been reached in regard to the tolerances. Price 3s.

THE ENGINEER

NOVEMBER 10, 1950

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

DEATHS

ON October 27th, at Budleigh Salterton, THOMAS PERCIVAL WILMSHURST, M.B.E., M.I.E.E., late Electricity Commissioner, aged eighty-one.

On November 5th, SIDNEY CLARENCE BUNN, M.I.Mech.E., M.I.E.E., 42, Kinross Avenue, Worcester Park, Surrey.

NAVAL REARMAMENT

IT has been a profound shock to the British people to realise that in spite of an annual expenditure of more than £760 million on the Armed Forces this country has no trained formations to put into the field in an emergency. Even to produce a brigade group to send from this country in support of the United Nations forces in Korea has strained our resources to the utmost and it is not surprising that when the Government's rearmament proposals were discussed by Parliament in mid-September, measures to strengthen the Army and Air Force formed the main subject of the debate. Both the Prime Minister and the First Lord of the Admiralty made but brief and vague references to the no less serious business of naval rearmament and it was only a fortnight ago that the details of the naval building programme were announced by Mr. Callaghan, the Parliamentary Secretary to the Admiralty, in reply to a Parliamentary question. Russia is believed to have one battleship and three cruisers under construction, but in comparison with the navies of the Atlantic Treaty Powers the number of large surface warships she has ready for sea is insignificant. She has, however, over 300 submarines, many of which, according to the Minister of Defence, are of modern design. She also possesses an immense number of aircraft and in past wars has proved her ability to manufacture mines of very effective types. Clearly, therefore, the threat to our sea communications comes from submarines, mines, aircraft and, to a lesser extent, from armed merchant ships.

The naval building programme announced by Mr. Callaghan seems in no way adequate to meet these dangers. There is to be a speeding up in the construction of six of the nine aircraft carriers, which were commenced during the war, and they are to join the fleet between now and 1954. These ships—the 36,800 ton "Eagle" and "Ark Royal," and the four larger and faster light fleet carriers of the "Albion" class—are required for general reconnaissance duties and Task Force operations, but are not the escort carriers needed in large numbers to accompany merchant ship convoys across the wide oceans. Two anti-submarine frigates of new design (including the one already provided for in the Navy Estimates) and a total of forty-one new minesweepers, are to be laid down; six destroyers will be in hand by the end of 1950 for conversion into anti-submarine frigates, with more to follow in 1951; and a start is being made on building up stocks of degaussing (anti-magnetic mine) and other equipment for the protection of the Merchant Fleet in war. But surely it is urgently necessary to replace our wartime frigates which cannot keep contact with, far less destroy, modern submarines, with high submerged speed? It is therefore disappointing to learn that only two frigates of new design are to be laid down. The type of ship required is not in doubt—a vessel of between 1500 and 2000 tons, lightly gunned with a strong anti-submarine armament, a speed of between 30 and 35 knots and large endurance—but it seems that the Admiralty has not yet sufficient confidence in the designs it has been investigating during the past five years. In principle, the conversion of existing destroyers into anti-submarine frigates is sound, for they possess the required speed. Moreover, the destroyer was built to attack battleships by day and by night and to overcome gun opposition from escorting enemy destroyers in the process of doing so—a function which is no longer required of her in a foreseeable war. There is thus little purpose in retaining her heavy gun armament or in maintaining all our existing vessels of this type in service as fleet destroyers. On the other hand, her conversion into an anti-submarine frigate merely makes her a more efficient escort vessel, but does not add to the number of anti-submarine vessels available. With some 200 destroyers or other effective anti-submarine vessels at the outbreak of World War II, we had the greatest difficulty in dealing with thirty German U-boats. Now we might be faced with some 300 Russian submarines—apart from the atom missile, which necessitates smaller and more numerous convoys and correspondingly more escort vessels. No less important than the number of anti-submarine vessels is the modernisation of anti-submarine detecting installations, which were not reliable in the last war when operated at speeds of over 18 knots. The modern submarine with extra batteries is capable of speeds of up to 20 knots for short periods submerged and we are likely to be faced with even higher speeds in the immediate future. The U.S. Navy has recently been authorised to build two prototype submarines driven, one by atomic power and the other by two Walther cycle engines, which the Germans, who invented this engine, claim will give her an underwater speed of 25 to 26 knots. Neither the atomic powered nor the German engine requires air and these submarines will be able to navigate for prolonged periods at any depth desired, independently of the Schnorkel. It is thus very satisfactory to have the Parliamentary Secretary's assurance that the development of anti-submarine detecting devices is fully keeping pace with developments in the submarine's power and that the highest priority is being given to this work.

It is welcome news that some attention is at last being paid to the special problems relating to the Merchant Navy in time of war, but the House might well have been given more information on that subject. Does the equipment now being supplied include the storing of guns at convenient ports throughout the world and arrangements for mounting these guns in merchant ships? Are ships to be provided with the necessary equipment for the unloading of heavy gear in harbours where large cranes and sheer legs are not available? A great deal of tonnage was wasted in the last war through the lack of such facilities at the ports to which heavy cargoes were consigned and this loss could have been avoided if merchant vessels had been provided with large sectional sheer legs and a petrol driven capstan motor for landing with them. Many merchant ships will also be required for conversion into small escort carriers to work with convoys. Have they been earmarked? In view of the danger from submarines and mines, it is essential to concentrate our resources on the construction and refitting of ships required to deal with it and the Parliamentary Secretary referred with obvious pride to the completion of the refits of 450 ships of the Reserve Fleet (mainly anti-submarine vessels and minesweepers). None the less, our cruiser position gives cause for real anxiety and it is regrettable that the building programme omits any reference to the three cruisers of the "Defence" class, whose construction has been suspended pending a decision on their armaments. The British cruiser force is now reduced to twenty-six ships, a number

which is very far from adequate to provide for Task Force operations and for the defence of local areas of trade throughout the world.

TRAINING OF TECHNICIANS

For many years now it has been appreciated that industry has a need for two varieties of professional engineers. Upon the one hand it requires academically trained men who have acquired some practical knowledge from a short apprenticeship, and upon the other it needs men rich in the practical knowledge that a full apprenticeship can give, leavened by theoretical study. To-day, therefore, there are two routes of advancement towards the attainment of corporate membership of the major engineering institutions. The more academic route leads through courses at a University or a college to the acquirement of a degree, and is followed by a relatively short period of practical experience in the shops; the other, more practical, route is open to young men undergoing full apprenticeship, through the successful completion of a Higher National Certificate Course at a technical college. The training of professional engineers is thus fully provided for.

But the engineering industry does not need only professional engineers at one end of the scale and craftsmen at the other. There is a very large intermediate field in which places can be found for men with qualifications less complete or more specialised than those needed for professional status, but skilled, in hand and in mind, in the use of techniques which are not those of the craftsman. The need of industry for such men has heretofore been filled by those who, though following the same educational courses, have not attained the standard required for professional status, or who have specialised early upon too narrow a group of subjects to earn professional status. Industry has been left, in its own fashion, to train such men further for the particular tasks they have been expected to perform. To date the Institutions of Civil and Mechanical Engineers have undoubtedly felt that, in developing and encouraging courses such as those for the National Certificates, provision has also adequately been made for those who do not desire or are unfitted to reach full professional status as chartered engineers. The Institution of Electrical Engineers, however, has thought otherwise and since the war it has devoted considerable attention to what it has termed "technicians," a definition of whom it devised some years ago. A step further has now been taken. In 1945 there was convened a Joint Committee on Practical Training in the Electrical Engineering Industry, composed of representatives of the British Electrical and Allied Manufacturers' Association, the Radio Industry Council, and the Council of the Institution. That Committee at first gave attention to the training of professional engineers, issuing a report on that subject in 1947. But it then turned to consider the training of "technicians" and last week it issued a report on that subject, a report whose main conclusions are mentioned on page 442 of this issue. In one sense that report may be said to confirm the value for "technicians" of present educational arrangements. For it recommends that the training course required by technicians should consist of two parts. The first part, a basic one, should be provided by technical colleges and should be in essence a National Certificate course. The second should be a part specialised upon the particular subject to become the field in which the technician will work, to be provided, as convenient, either within industry or through the co-operation of industry with the local technical college. It is, however, felt, in relation to the second, specialised, part of the training of technicians, that present facilities are inadequate in quantity and extent, and in relation to the first part that some modification of National Certificate courses may be desirable.

Although a short definition of an electrical "technician" is given early, nearly the whole of the first half of the report is given up to a discussion of what is meant by a technician, what occupations are filled by technicians, and what qualifications are needed by them. But the object of the Committee in writing so extensively on those subjects was, no doubt, less to define the meaning of the word "technician" than to show how extensive is the part played by technicians in industry and how varied are the tasks performed, in order the better to indicate what qualities should be developed in their training. The range of tasks performed is, indeed, revealed to be so wide that except in basic education no general standards of training can be laid down. The Committee does make suggestions for certain specialised courses for which it feels there is a clear need. But, to judge from the report, requirements can only be fully met by encouraging industry itself to take the initiative in co-operating with local colleges in the development of specialist courses or in starting training courses within industry itself. To some extent that action has, of course, already been taken. The report is restricted in scope to the training of electrical technicians. But the problem with which it deals is common to all branches of engineering and the report is therefore worthy of the attention of civil and mechanical engineering firms besides those in the electrical industry.

Obituary

G. A. HANKINS

We record with deep regret the death, at the early age of fifty-five, of Dr. G. A. Hankins, Director of Mechanical Engineering Research in the Department of Scientific and Industrial Research. It occurred with tragic suddenness on Thursday, November 2nd, while he was in the process of moving into the house he was to occupy near to the new mechanical engineering research station at East Kilbride, Scotland.

G. A. Hankins

George Alexander Hankins was born at Portsmouth on April 25, 1895, and after receiving the earlier part of his education at the Portsmouth Grammar School, he was accepted as an engineer-apprentice at Portsmouth Dockyard and continued his studies at the Royal Dockyard School. Subsequently he gained a Whitworth Scholarship and was a Royal Scholar at the Imperial College of Science and Technology.

At the beginning of the First World War Hankins served in the Army for a year, but in 1916 he was appointed to the Admiralty Engineering Inspectorate, and, at Portsmouth Dockyard, was responsible, among other matters, for the examination and acceptance of special gun mechanisms made under contract. A year later, however, Hankins joined the staff of the engineering division of the National Physical Laboratory, and thus began an association with that establishment which continued, without a break, until—and even beyond—his appointment as Director of Mechanical Engineering Research, D.S.I.R., in 1947. In the earlier part of his career at Teddington Hankins was directly responsible to the Superintendent of the Engineering Division, at that time the late Dr. T. E. Stanton, for the organisation and carrying out of specific researches in mechanical engineering and allied subjects. His papers to the Institution of Mechanical Engineers and to other learned societies recorded many of the researches which he undertook, and in 1928 he was awarded the degree of D.Sc. (Engineering) in the University of London for various published researches.

In 1931, Dr. Hankins was promoted to the post of Senior Scientific Officer in the Engineering Division of the National Physical Laboratory and became generally responsible for the work of those sections of the department dealing with the strength of materials and also road research. The onset of the Second World War naturally meant a big increase in the amount of work that the N.P.L. was required to undertake, and Dr. Hankins' advice and counsel were continually sought by many Government and other committees concerned with engineering research. In 1944, following the resignation of Dr. S. L. Smith, Dr. Hankins was appointed Superintendent of the N.P.L. Engineering Division, a position which he occupied with distinction and ability until the reorganisation of the Department of Scientific and Industrial Research in 1947. It will be recalled that in June of that year the Government announced the establishment of the Mechanical Engineering Research Board and invited Dr. Hankins to serve as Director of Mechanical Engineering Research. Until such time as it was possible to find a suitable site and to proceed with the construction of a mechanical engineering research station much of the work of the new organisation was carried on under Dr. Hankins' supervision at the National Physical Laboratory. Before the end of 1947, however, it was decided that East Kilbride would be a suit-

able location for the projected research establishment, and work on its construction has since then been continually in progress.

Reference has already been made to the published reports of many of Dr. Hankins' researches in the form of papers to the learned societies. Among them may be mentioned his series of papers on hardness testing, which described work carried out for a research committee of the Institution of Mechanical Engineers. Dr. Hankins' researches into the effects of surface conditions on the fatigue resistances of steels undoubtedly led to the improved utilisation of engineering materials and also influenced steel manufacturing processes. Another investigation with which he was associated was a statistical examination of the strength of welded joints, a research which led to important developments in the application of electric welding to steel structures. Dr. Hankins was elected an Associate Member of the Institution of Mechanical Engineers in 1925 and was transferred to full membership in 1939. He served on the Council from 1933 to 1936, and to the centenary celebrations of the Institution in 1947 he contributed a lecture on "Fluid Mechanics." He had been a member of the Institution of Civil Engineers since 1934, was awarded the Crompton Gold Medal of the Institution of Automobile Engineers in 1935, and delivered the Andrew Laing Memorial Lecture to the North-East Coast Institution of Engineers and Shipbuilders in 1943 on "Experimental Fluid Dynamics Applied to Engineering Practice."

When an old man dies, loaded with years and the honours time has brought him, we feel heavily the passing of a personality. Yet we know also that time was at least granted such a man to make to the full his mark upon his contemporaries and to perform those tasks in life for which his qualities fitted him. But how differently we feel about Dr. Hankins' death! Here was a man sufficiently advanced in years and reputation for his quality to be widely recognised amongst engineers. Here, too, was a man who had just earned for himself on the credit of his past achievements a job that he was undoubtedly peculiarly well fitted to carry out, the organisation and operation of the research station at East Kilbride. Dr. Hankins was not merely a man of promise. His reputation was established. But his achievements were incomplete. The major part of them lay in the future. Those who knew him, those who were aware of his quiet but firm character, were sure that under his wise guidance the new research body would early earn a high reputation. No doubt it will do so under Dr. Hankins' successor. But it will now earn it in some different way, take on a different character. We shall never know what Dr. Hankins would have made of it had he lived a longer span. All that we can know is that knowledge of the ideas he would have expressed in its organisation and its methods would have been of value to us. For fate has robbed the engineering industry of a man whose major tasks still lay before him.

JAMES PEACOCK

MARINE engineers will regret to learn of the death of Mr. James Peacock, which occurred in Edinburgh on October 30th, at the advanced age of eighty-five. Until his retirement at the end of 1938 Mr. Peacock was superintending engineer of the Orient Steam Navigation Company, Ltd.

James Peacock was born in Glasgow and was educated at Allan Glen's technical school. In 1882 he began an apprenticeship with Lees, Anderson and Co., Ltd., and five years later entered the drawing-office of John Brown and Co., Ltd., Clydebank. In 1899 Peacock was transferred to the Sheffield branch of John Brown and Co., Ltd., where he became works engineer, but in the following year he left that company to join the engineering staff of the Orient Steam Navigation Company, Ltd. During his thirty-eight years' service there were, of course, several notable developments in the Orient Line with which Mr. Peacock was closely concerned. Those developments included the building of fifteen ships, starting with the first "Orontes" of 9023 tons in 1902 and ending with the pre-war Orient liner the "Orcades," of 23,456 tons, built in 1937.

LORD ROYDEN

LORD ROYDEN, whose death we regret to note, occurred at Brockwood Park, Alresford, Hampshire, on Monday last, November 6th, occupied a distinguished place in this country's shipping, railway and other commercial interests. Thomas Royden was the eldest son of Sir Thomas Royden, the first baronet, and was born on May 22, 1871. He was educated at Winchester and at Magdalen College, Oxford, and began his long business career with the Cunard Steam-Ship Company, of which he became a director in 1905. A few years later he was appointed deputy chairman of the company, and became its chairman in 1922.

Subsequently Sir Thomas—he succeeded to the baronetcy in 1917—retired from the chairmanship of the Cunard Company, but continued to serve on the board and also as a director of Cunard White Star. Sir Thomas was created a Companion of Honour at the conclusion of the First World War, and the First Baron Royden of Frankby in 1944. There were other shipping and commercial interests with which Lord Royden was for long associated. They included the Port Line, Brocklebank Line and the Shell Transport and Trading Company. He was also a past-chairman of the Liverpool Steamship Owners' Association and a past-President of the Chamber of Shipping of the United Kingdom. In addition, Lord Royden was a director of the Midland Bank and of the former London, Midland and Scottish Railway Company, to the chairmanship of which he succeeded on the death of Lord Stamp.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

FACTORY ACCIDENTS

SIR,—Like many other engineers, I have read with the deepest interest the two articles which Sir Alfred Herbert has contributed to your valuable series on "Productivity." It is to be hoped that not only managers and foremen, but workpeople also have read and digested them.

Is it fair to ask Sir Alfred for a little further information from the annals of his own works? The information asked for is concerned mainly with the human element. My first question is a difficult one. Is it possible to separate mishaps that are genuine accidents from those that are due to the negligence of the sufferer, or the negligence of someone else, other than the management? My second question is, does he find that certain individual operatives are especially prone to accidents? I recall from my 'prentice days the case of a yard labourer, a steady and useful man, who had to be discharged with regret because things were always falling on him, apparently through no fault of his own. My third question is, do Sir Alfred's returns show any relationship between the ages of the workers and the incidence of accidents? Finally, are women and girls more or less prone to accidents than men and boys?

I am aware that some official returns provide analyses of accidents, but in general they are derived from a large field. It would be of great value to have the records from one firm of engineers, and especially from a firm that has paid such close attention to accident prevention as Sir Alfred Herbert's.

L. P

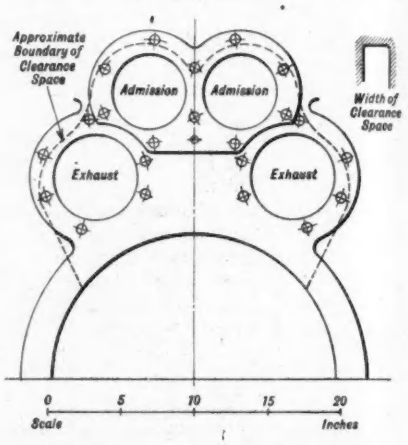
London, November 6th.

SOME AMERICAN LOCOMOTIVES AND THEIR RUNNING

SIR,—The articles by Dr. Tuplin on American locomotives make most interesting reading, as they convey a vivid idea of footplate riding on locomotives unfamiliar to most British engineers.

Size is, of course, impressive and so is high speed, but it is difficult to assess the effective performance of these large engines unless data is available on power output. It is evident that in America, late-cut-off working is usual practice, even on level track running, so it may be assumed that fuel consumption is high, especially as Dr. Tuplin several times refers to the dense smoke emitted from the chimney. This indicates that fuel is not being completely burned.

It is also a surprise to the writer to know that many American engines are not fitted with



a cut-off indicator, as one imagined that they were equipped with all kinds of modern aids to efficient operation.

I wonder if Dr. Tuplin could afford some information on the following points:—

(1) Examples of power output on gradients.

(2) Fuel consumption on weight/drawbar-horsepower-hour basis.

If it would not cause him embarrassment, could he give his opinion as to whether American locomotive engineering is ahead of British practice, or whether development has been chiefly directed toward large power output and high speed, without much concern for efficiency.

It is obvious, of course, that the practically unrestricted loading gauge in America has permitted experiments to be made with very large locomotives having divided drive, thus obtaining the advantage of a large number of coupled axles without the disadvantage of a long rigid wheelbase. This must lead to mechanical complication and possibly heat losses through the necessity for lengthy steam pipes.

Finally, a point regarding the so-called "engineer." Does he graduate to his job via a long period of service as cleaner and fireman, or is there some more advanced method of training men for handling these apparently complex machines?

L. H. LEEDHAM, M.I.Mech.E.

Leicester, September 21st.

The Fifteenth Commercial Motor Show

(No. V—*Continued from Supplement, page 2, November 3rd*)

THIS article, which concludes our review of the Commercial Motor Show, is mainly concerned with gearboxes, rear axles, and general conclusions.

Synchromesh gearboxes for the heavier types of commercial vehicles have been built in the past, but, owing to the large size of the synchroniser cones, they used to be rather heavy and expensive, and never became very popular, although their value in reducing driver fatigue has been readily acknowledged.

The gearbox of the "Big Bedford" (Fig. 12) is a great improvement in this respect, and, for an input torque of 240 lb-ft it is comparatively short and light. Top, third and second gear are fitted with synchronisers; the constant-mesh second and third gears have helical teeth, and (like the reverse idlers) are fitted with steel-backed, lead-bronze bushes.

The orthodox "crash" gearbox is still being used to a large extent for the heavier vehicles. In public transport, however, it is gradually being replaced by the improved version, having a centre bearing for better

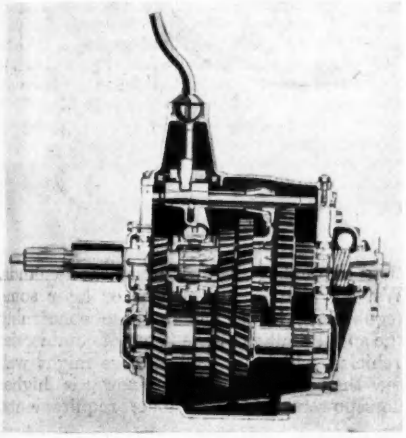


FIG. 12—FOUR-SPEED SYNCHROMESH GEARBOX—VAUXHALL

support of the shafts, or by the constant-mesh gearbox with helical gears for all but the bottom and reverse gears. A gearbox of this kind (Fig. 13) is the four-speed unit (with an auxiliary "super-low" gear) of the Foden rear-engine coach. This gearbox also houses the spiral bevel gear to the clutch output shaft and the helical gear for the fan drive.

A similar gearbox by the same manufacturers, developed for heavy duty goods vehicles, particularly overseas, is fitted with an auxiliary epicyclic unit. A close-ratio set of gears is used which, in conjunction with the 3·29 to 1 reduction of the epicyclic unit, give a very comprehensive and evenly spaced range from direct to 15·1 to 1 ratio. In conjunction with a double reduction axle, this gearbox is capable of dealing with gross loads of the order of 80 tons. The principle of this reduction gear will be readily understood by reference to Fig. 14. Positively located on the tailshaft of the main gearbox is the sun-wheel, the cylindrical extensions of which form the inner races of the roller bearings on which the planet carrier runs. The planet wheels, carried on roller bearings on the pinions, mesh with the sun-wheel as well as with the annulus which is bolted to the housing. The sliding member on the splined input shaft, connected with the propeller shaft, is fitted with external dogs which, in the left-hand position, engage the internal dogs of the sun-wheel, thus providing the direct drive. When shifted to the right, they mesh with the internal dogs of the planet carrier, thus causing the input shaft to rotate at reduced speed.

The gear change takes place by shifting the control rod by a pre-selective lever, positioned on the driver's left hand, to one of its end positions, thus pre-loading the shift-fork by tensioning the coil spring. The auxiliary box then changes gear automatically when the clutch is depressed for the main change, or the vehicle overruns.

Although the auxiliary box theoretically provides the choice of eight speeds, the reduction gear will be mainly used in conjunction with the top and third gear of the main box. When properly handled, it can be very useful where road conditions and loads demand long periods in indirect gears, but its operation requires from the driver a certain amount of manual skill and mental alertness.

REAR AXLES

No innovations are to be reported as far as rear axles are concerned. The worm drive, unsurpassed for its capacity to withstand heavy transmission and shock loads without sustaining fracture of the gear teeth has proved its value for many years. Owing to its inherent silence and its high transmission efficiency for ratios up to about 10 to 1, it is the ideal drive for buses, trolley-buses and for heavy vehicles with two driven rear axles. For continuous operation at slow speed and full load, however, the worm drive is subject to high gear temperatures and is rather expensive. Ordinary goods vehicles, with the exceptions mentioned above, are generally fitted with rear-axle drives of either spiral-bevel or hypoid gears, the latter being of comparatively recent introduction. The hypoid combines strength with high transmission efficiency, and, for single reduction axles, shows improved pinion strength as compared with a spiral-bevel gear reduction. The input pinion shaft is offset below the axle centre line

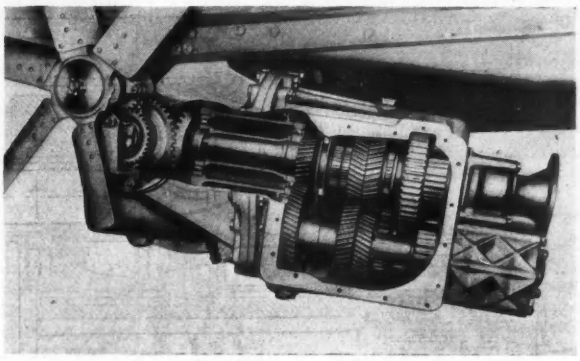


FIG. 13—SPIRAL BEVEL DRIVE AND GEARBOX—FODEN

resulting in the transmission line being lower than that of the spiral-bevel axle. Medium weight vehicles, requiring axle ratios between 5 to 1 and 7½ to 1, are now able to employ a hypoid drive where previously the use of spiral-bevels has been prevented by the weakness of the pinion teeth.

For ratios beyond the range of either worm or hypoid gears, particularly for very heavy duty on large-capacity buses and for large tractor-trailer goods vehicles, the double-reduction rear axle is the only solution. An interesting example of this class was to be seen at the stand of Kirkstall Forge Engineering, Ltd., employing a spiral-bevel gear as first reduction and an epicyclic gear in each wheel hub as the final reduction. As shown in Fig. 15, the sun-wheel is splined to the half-driving shaft which transmits the drive through triple planet pinions to the internal annulus gear, which is made integral with the hub cab. As the final gear reduction is placed at the points nearest the wheels the half-driving shafts are relieved of the high wheel torque and carry only the reduced torque from the primary reduction in the differential centre.

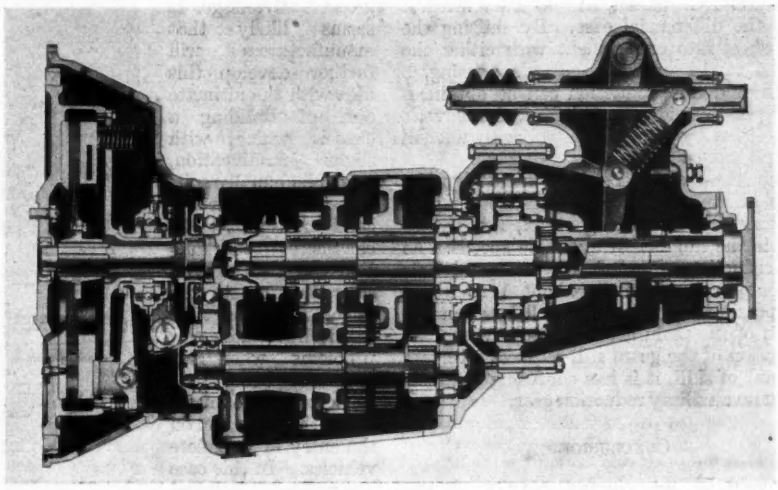


FIG. 14—EIGHT-SPEED GEARBOX—FODEN

For some special applications it is more desirable to locate the double-reduction gear in the centre of the rear axle, as is being done in the two-speed unit of Eaton

in themselves, but the way in which the various technical problems involved have been solved, and the ready acceptance of them for practical use has been a pleasant

British design to a large extent for a long time to come. Our manufacturers will have to make further representations to the authorities for the relaxation of legal restric-

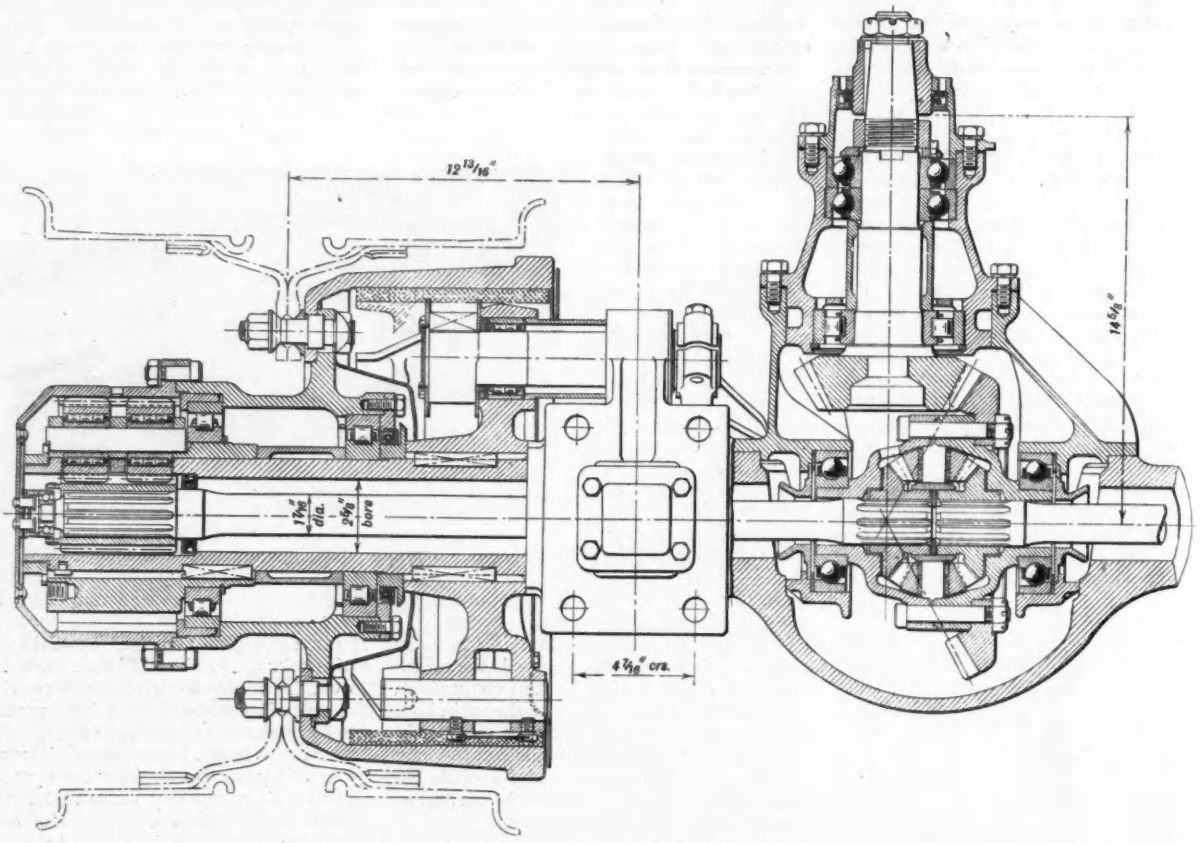


FIG. 15—DOUBLE-REDUCTION GEAR—KIRKSTALL

Axles, Ltd. This axle, as shown in Fig. 16, functions prominently as a standard reduction unit, the ratios being obtained through a spiral-bevel *A* and a matched crown wheel *B*. Integral with the crown wheel are internal gear teeth, forming the annulus of an epicyclic gear. The sun-wheel *C* slides on the half-shaft *D* and the planet carrier with the four planet wheels *E* is integral with the differential case. By shifting the sun-wheel into engagement with either the planet carrier or with the axle housing, a single or double reduction can be obtained. The gear-shift is actuated from the driver's seat, either by vacuum control or by a small electric motor.

The two-speed axle has essentially the same effect as an auxiliary reduction gear attached to the main gearbox, namely, to double the number of available speeds. As the reduction ratio of the two-speed axle is comparatively small—about 1 to 0·7—the possible reductions fit well between the ratios of the main gearbox, and though the operation of the gears still requires a certain amount of skill, it is less confusing than the use of an auxiliary reduction gear.

Conclusions

The show was remarkable in several respects. One does expect, of course, that an exhibition should give a comprehensive representation of the latest progress made in design and production, but what we have witnessed this year was more than a display of ordinary evolutionary development. Admittedly, the basic ideas leading to the new engine mountings, chassisless bodies, automatic transmissions, &c., are not novel

surprise. It emphasises the strength and the flexibility of our motor industry to adapt itself to any change of circumstances and conditions which may arise in the future.

Reference has been made to the almost unanimous adoption of the under-floor engine for passenger vehicles, in which sphere it shows to greatest advantage. It seems likely that manufacturers will further develop this idea with the ultimate aim of building a chassis which, with slight modification, might be equally suitable for passenger and goods transport. The chassisless construction can also be considered a great step in the right direction, but it introduces new problems when attempts are being made to export to countries where there is a ban on the entry of complete vehicles. In this case a complete "knocked down" system is necessary, not only to provide employment locally, but also to reduce freight charges which are one of the more expensive factors in exporting.

It is difficult to foresee the future development of commercial vehicles. Export requirements will probably continue to influence

tions where they clash with overseas demands. We can assume that sooner or later some regulations, in particular those concerning the speed limit for some types of commercial vehicles, will be altered and we might well see then a general move towards higher horsepowers even for home requirements.

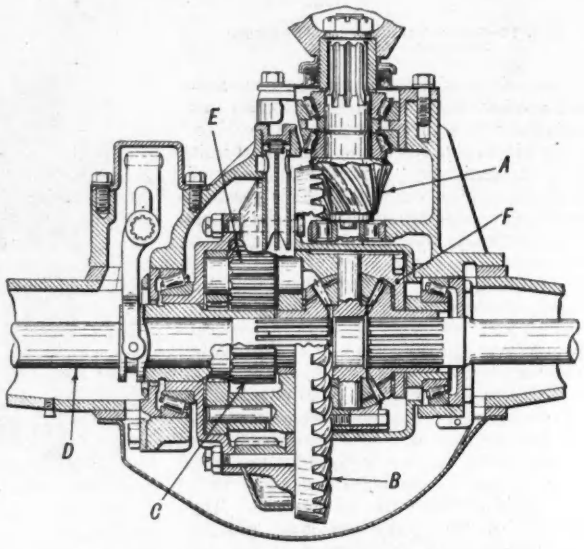


FIG. 16—TWO-SPEED REAR AXLE—EATON

The accommodation of the straight engine of increased size in the present-day chassis will certainly confront the designer with some problems, and it might well be that he will have to increase engine speed or to

raise the mean effective pressure by supercharging or other means. The further development of new two-stroke engines or the adoption of different cylinder arrangements—for instance, V-engines—might be some alternative solution.

If such hopes are to materialise, British road users have first of all to be favoured by a more enlightened policy on roads which have not kept pace with the rapid development of road transport. We cannot do better than to conclude our review with a quotation from the speech of the Minister of Transport on the occasion of the opening of the show: "I wish that a Minister could command the funds so that I might have been able to build roads in this country worthy of this great range of vehicles."

Swiss High-Voltage Air-Blast Circuit Breakers

IN last week's issue (p.419) we referred briefly to a demonstration of air-blast circuit breakers and system protection, which was staged a few weeks ago by Brown Boveri and Co., Ltd., Baden. The meeting, which we attended, lasted two days, the first day being occupied with lectures and demonstrations of protective equipment in the company's Baden works and research laboratories, while the second day was spent in a visit to the low-head hydro-electric station at Lavey, where we were able to see a typical switchgear installation based on some of the circuit breakers seen the previous day.

Development

Since May, 1946, when the company demonstrated its post-war range of air-blast indoor circuit breakers with ratings up to 30kV and 1000A, development work has been concentrated on extending this range to 60kV and 4000A. At the same time a new range of outdoor circuit breakers, covering voltages between 80kV and 400kV, has been evolved. The same general principles were applied to both developments. Controlled multiple breaks, using one or more identical arcing chambers, were used for the higher voltages, electric stress distribution being effected by non-linear resistances or capacitors.

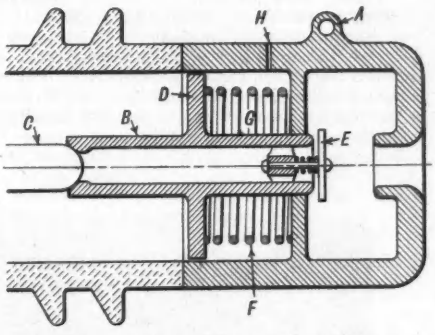
In the earlier indoor circuit breakers an isolating switch was used to bridge the arcing chamber. Subsequent circuit breakers, however, with ratings over 1000A, were designed with greatly increased contact pressure to carry the rated current continuously without overheating; accordingly it was possible to eliminate the isolating switch. The necessary contact pressure is obtained by the use of powerful springs and robust mechanical construction, the operating and damping forces being produced pneumatically. These considerations combine to produce a high-speed, high-current circuit breaker.

Its suitability for high-speed reclosing was well demonstrated with the help of a 60kV, 1200MVA circuit breaker connected to a supply line and transformer feeding a motor-driven loom representing an industrial consumer. Arcing short circuits were imposed on the line and the circuit breaker was opened and reclosed after a dead time of only 0·25 second without interrupting the operation of the loom.

Outdoor Circuit Breakers

The new range of outdoor circuit breakers is the realisation of an attempt to meet any conceivable system requirements using equipments built up mainly of a number of standard sub-assemblies. Of these components the most important is the arc extinction chamber, which is common to the whole range of circuit breakers. Our first illustration shows one phase of a typical circuit breaker comprising four arcing chambers in series, arranged horizontally and supported, in pairs, by two vertical post insulators on a common base, which consists of a welded air receiver. Control capacitors for equalising the voltage distribution are mounted horizontally just above the extreme left-hand and right-hand interruptor units. Compressed air for opening the contacts and extinguishing the arc is supplied to the arcing chambers via the vertical insulators, the main air valve and its control apparatus being contained in a centrally disposed housing on the air receiver.

The principle of operation of the arc extinction chamber is shown, greatly simplified, in the accompanying diagram. When the circuit breaker is closed the chamber is at atmospheric pressure and current flows from the lug *A*, through the hollow moving contact *B* to the fixed contact *C*. To open the circuit compressed air is admitted through the hollow insulator into the chamber, where it acts on the piston *D*, overcomes the spring pressure and moves the hollow contact to the right. Upon separation of the contacts a blast of air flows through the hollow contact (which acts as a nozzle) and out to atmosphere, extinguishing the arc in the first or second half-cycle and building up a high insulation value across the gap, to prevent restriking of the arc. The initial movement of the hollow contact is limited by the air trapped in the chamber *G*, ensuring that arc extinction is achieved with the optimum contact separation. Then, as the air escapes via the port *H*, contact separation is increased until, finally, the valve *E* closes the outer exhaust port and effectively seals off the circuit breaker from atmosphere.

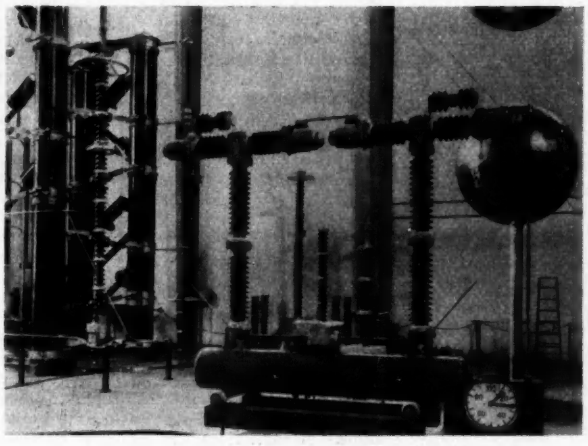


PRINCIPLE OF ARC EXTINCTION CHAMBER

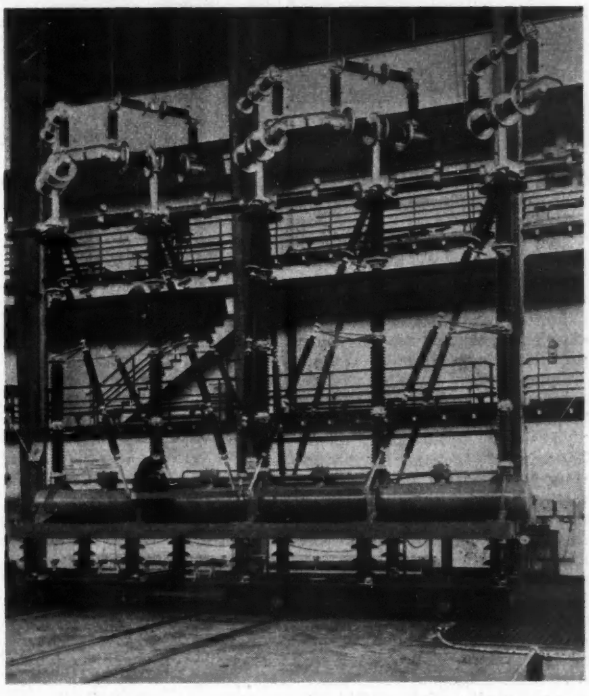
As long as the circuit breaker is required to remain open the arcing chamber is under full air pressure, which, in conjunction with the large contact separation, ensures reliable isolation of the circuit, and the need for an isolating switch is eliminated.

The circuit is "made" by releasing the air pressure in the chamber, whereupon the spring *F* closes the contacts.

The arc extinction chamber described above forms the basis of all the circuit breakers in the range, the number of chambers in series depending on the working voltage. Two methods are used to attain a more-or-less uniform voltage distribution across the series breaks: the first is to connect control capacitors across the more highly stressed of the arc extinction chambers; the second method is to use shunt resistors across all the chambers. The resulting knowledge of the voltage distribution during the switching process justi-



AIR-BLAST CIRCUIT BREAKER ARRANGED FOR IMPULSE TESTING

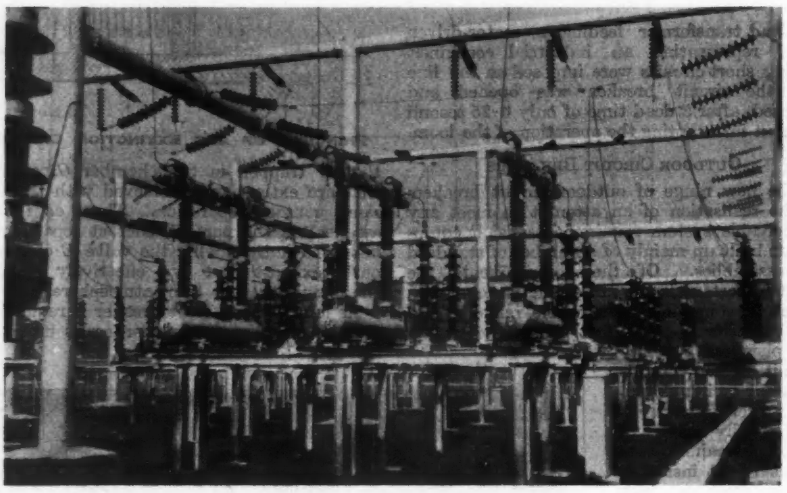


SINGLE PHASE UNIT OF 380kV CIRCUIT BREAKER

fies the practice of "synthetic" testing, whereby each chamber is tested for the portion of the interrupted power that it is designed to handle and the series of tests corresponds to a test on the complete circuit breaker. Some results of such tests are given in *The Brown-Boveri Review*, 1950, Nos. 4/5, page 128.

Typical examples from the range of outdoor circuit breakers are illustrated herewith. One of the photographs reproduced on this page shows a three-phase, 150kV equipment installed in the switching station at the Lavey power station of the Lausanne City Electricity Supply Authority. The use of a tubular structure for the substation is noteworthy.

The most interesting circuit breaker in the new range is the 380kV unit, which is shown in one of our illustrations, erected for testing in the Brown-Boveri high voltage laboratory at Baden. This equipment embodies five pairs of arc extinction chambers, which, viewed in plan, are inclined at 45 deg. to the main axis of the circuit breaker. Each pair of chambers is shunted by resistors. Disposed horizontally below the chambers are the control capacitors. Our illustration shows the general form and arrangement of the electrodes, which are designed to prevent the occurrence of brush discharges.



150kV SWITCHGEAR AT LAVEY POWER STATION

The complete assembly of arc extinction chambers and control resistors and capacitors is supported on an insulator structure embodying a system of stays, which are so disposed that their members are stressed in tension only. Apart from these structural differences, the circuit breaker is built up mainly of standard components.

The single-phase unit shown on page 441 is typical of the equipments that are being supplied for the Swedish 380kV transmission system. Three such units assembled as a three-phase circuit breaker have a rupturing capacity of 8600MVA at a maximum service voltage of 400kV.

Insulation Co-ordination

The demonstration at Baden was largely concerned with the problems of insulation co-ordination, and showed something of the attention that is devoted to grading the insulation strength to prevent breakdown due to power-frequency over-voltages, flashovers being allowed only at points where no damage can result.

For example, a 150kV air-blast outdoor circuit-breaker was subjected to artificial lightning strokes produced by the 25kW-sec., 2400kV impulse generator, which is installed in the company's high voltage laboratory. The 660kV over-voltage waves were discharged by spark gaps, the insulation between the open circuit-breaker contacts, which was simultaneously stressed, being thereby protected against flashovers. Steep wave-front surges of 1400kV were satisfactorily discharged by the Resorbit lightning arrestors connected to the breaker, thus preventing flashovers on the breaker or across the spark gap.

A further series of tests demonstrated the high electric strength of the arc extinction chambers. Since circuit breakers may be subjected to very high voltage stresses at the instant of rupture, special importance was attached to obtaining a high impulse strength between the open contacts. A test showed that with a normal air pressure of 15kg per square centimetre (about 220 lb per square inch) the electric strength of the chamber was higher than 150kV. With a constant applied voltage of about 125kV the air pressure in the chamber was then gradually reduced until a flashover occurred inside, which was at about 3kg per square centimetre (about 45 lb per square inch). Since the breaker is designed for a minimum air pressure of 14kg per square centimetre (about 205 lb per square inch), the result is very satisfactory. In service the arc extinction chamber is subjected to a recovery voltage of 50kV, but its electric strength as was demonstrated, is over 150kV.

Insulating problems on 220kV and 380kV systems were demonstrated on two similar post insulators, one being subjected to artificial rain, while the other was tested dry. On the 220kV insulators the flashover occurred, as was anticipated, on the wet insulator. When the 380kV insulators, with a distance between electrodes of 4m (13ft), were tested, however, it was not the wet insulator but the dry one, which flashed over, a surprising result, caused by differences in field distribution.

A method had therefore to be found to bring the flashover strength of the dry insulator up to that of the wet one. A further test on 380kV insulators showed that this result could be achieved by altering the arrangement and form of the electrodes. Two 380kV insulators, one with the conventional annular fitting and the other of a new form, designed to avoid brush discharges, were simultaneously subjected to a dry test. Whereas the insulator with an annular fitting flashed over at 850kV, after heavy preliminary discharges, with the same clearance between electrodes, the flashover voltage of the new fitting was over 1 million volts.

For the last demonstration of insulation co-ordination a single-phase unit of a 380kV air-blast breaker, was used. First, the closed breaker was tested with a voltage of 975kV to earth. Brush discharges, which normally occur at such high voltages, were virtually eliminated with the new electrodes demonstrated in the previous test. The same voltage test with the circuit breaker open (so that the ten series-connected arc extinction chambers were stressed with the test voltage of 975kV) again proved its high electric strength. The impulse strength of the breaker was convincingly demonstrated, for it withstood impulse waves of 1,800,000V. These impulses only resulted in flashovers to earth across the spark gaps provided for the purpose. The insulation of the series-connected arc extinction chambers did not flash over, the flashover strength of the break being over 2,000,000V.

The Education and Training of Electrical Technicians

A REPORT recommending the development of schemes of education and training for electrical technicians has just been published by the Institution of Electrical Engineers. The report has been prepared by a Joint Committee on Practical Training in the Electrical Engineering Industry, consisting of representatives of the Council of the British Electrical and Allied Manufacturers' Association, the Radio Industry Council, and the Council of the Institution of Electrical Engineers.

The numerical and technical importance of the group classified as electrical technicians, it is suggested, justifies attention being drawn to the problem of their education and training. In the course of its study of the problem the Joint Committee has carefully reviewed existing facilities. This review is considered to have revealed two main facts: first, that the status of electrical technicians is not nearly so well-defined, nor the importance of their systematic training so fully appreciated as is the case with professional electrical engineers on the one hand or with craftsmen on the other; and, secondly, that the facilities for education and training of technicians to meet their needs are inadequate in quantity and extent. No attempt has been made in the report to prescribe in detail either the training of the many different types of technicians engaged in the electrical industry or the courses of education that should be available for them; it was considered sufficient to concentrate attention on the underlying principles and other relevant considerations on which courses of education and schemes of training should be planned. It is recommended that the principal method of providing for these needs should be a four or five-year apprenticeship or training (the period depending on the standard of entry), with concurrent education at a technical college. An alternative method is the "works-based" sandwich scheme, which may be particularly appropriate where a number of firms can join together to provide adequate training in a co-operative scheme, which they would be unable to do individually. Special attention has been drawn to the practical aspects of training.

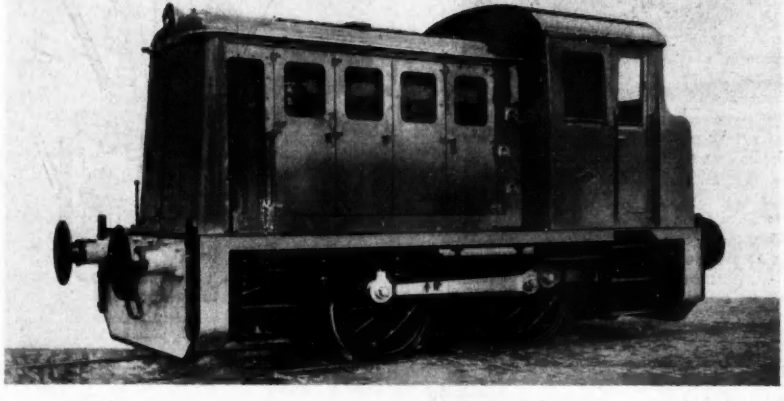
It is recommended that electrical technicians should have a basic course of education up to the standard of an Ordinary National Certificate, and that, subsequently, most of them will benefit by specialised courses. Attention has also been drawn to the standard of general education which should be required of a technician as a preliminary to the more technical qualifications needed by him. Stress is laid on the need to make provision for craftsmen who show promise, to transfer to training as technicians, and also for suitable technicians in training to transfer to student apprenticeships. A section of the report is devoted to apprentice activities and the need to encourage apprentices to take part in and to organise for themselves cultural and social activities outside working hours, within, wherever possible, the framework of an apprentice association. The Joint Committee has also recommended the proper supervision of apprentices and the need to appoint an officer whom apprentices can always approach for personal guidance.

Copies of the report may be obtained, price 1s., post free, from the Secretary, the Institution of Electrical Engineers, Savoy Place, London, W.C.2.

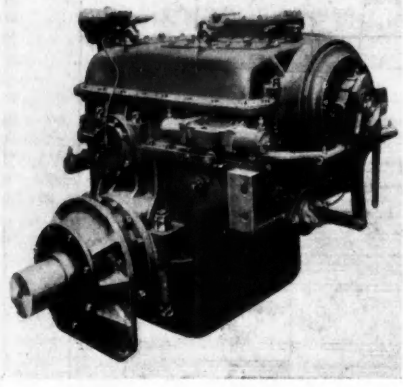
ELETTRA II.—The "Elettra," which was bought by the Italian Government, after the death of the late Marchese Marconi, to serve as a museum of wireless history, is to have a successor. A twin-screw diesel yacht 72ft long, has been acquired by the Marconi Marine Company and named "Elettra II." Fitted as a floating laboratory, the yacht will carry out advanced experiments and an extensive research programme.

Diesel Shunting Locomotive

As part of their large-scale development programme, Colvilles, Ltd., are replacing the steam shunting locomotives at their Clydebridge and Dalziel Steelworks with diesel locomotives. The first of two 300 h.p. locomotives, which have been designed for handling metal and slag ladles and general heavy steelworks duties, has been completed by the North British Locomotive Company, at their Atlas Works in Glasgow, and is illustrated herewith. The power unit is a Harland and Wolff six-cylinder, two-stroke engine, and the transmission is the S.S.S. Powerflow gearbox, which can be seen in the accompanying illustration. The driver's controls are duplicated on each side of the control desk and the driver has a very good view of the track in every direction. The principal dimensions of the locomotive are as follows :—



300 H.P. DIESEL SHUNTING ENGINE



"POWERFLOW" GEAR BOX

Length over buffers	23ft 5½in
Height	12ft 0in
Width	8ft 6in
Wheelbase	6ft 0in
Wheel diameter	3ft 6in
Weight in working order	40 tons

The starting tractive effort, calculated at 33 per cent adhesion, is 25,300 lb and three speeds in each direction are provided, the corresponding tractive efforts, which are attained by the addition of ballast, are shown in the accompanying table :—

Gear	Speed, m.p.h.	Tractive effort, lb
1	4½	22,500
2	8½	13,000
3	13	8,000

The engine has six cylinders in line, 5·9in bore by 8·65in stroke, with a power output of 300 b.h.p. at 1200 r.p.m. continuous rating, and safety devices warn the driver if the load exceeds 300 h.p. and if the engine speed exceeds 1320 r.p.m. The cylinder-head carries four poppet exhaust valves for each cylinder, grouped around a centrally placed fuel injector.

A 26in Vulcan-Sinclair fluid coupling transmits the torque from the engine to the gearbox, which is built by David Brown and Sons (Huddersfield), Ltd. The gearbox is operated by pneumatic controls and, in changing gear, the movement of the single change-speed lever also reduces engine speed slightly and then accelerates it again without the driver having to touch his throttle lever. First and second gear are engaged by the synchro-self-shifting dog clutch and third gear is taken through a high capacity twin-plate friction clutch. This clutch is pneumatically operated and is engaged while changing gear in the lower ratios, so providing continuity of tractive effort.

When in second gear the locomotive can be allowed to coast freely by the action of the SSS dog clutch, which moves into engagement at synchronism and into a free position when the locomotive overruns the engine. In third gear the SSS clutch remains in a free position, while the traction clutch is engaged. The gearbox contains the spiral bevel final drive and reversing sliding dog clutch and the torque is transmitted to the driving wheels by jackshaft cranks and side rods.

The four-coupled wheel arrangement allows the locomotive to negotiate sharp curves and the generous laminated suspension springs give smooth riding and very good adhesion when second-class permanent-way is being traversed. The overall length of the locomotive has been kept short to reduce the overhang of the buffers and the latter have large heads designed to prevent interlocking on short curves.

Contracts

CROSSLEY BROTHERS, Ltd., is to supply forty-eight eight-cylinder two-stroke loop scavenge diesel engines of 1100 b.h.p. for the diesel electric locomotives being built by Metropolitan-Vickers Electrical Co., Ltd., for the Western Australian Government Railways.

BURNTISLAND SHIPBUILDING COMPANY, Ltd., announces that it has received contracts for five motor vessels, to the value of £1,000,000; one of 9400 tons deadweight with Kincaid-Burmeister and Wain diesel engines for Turnbull Scott Shipping Company, Ltd.; two colliers, each of 2825 tons deadweight, with British Polar diesel engines for the South Eastern Gas Board, and two cargo vessels, each of 1640 tons deadweight, with British Polar diesel engines, for the Constantine Shipping Company, Ltd.

Form Grinding by Mechanical and Optical Methods*

By E. A. COOKE, A.M.I.Mech.E.†

No. I

INTRODUCTION

UNTIL some four years before the 1939–45 war, machine tools designed specifically for the purpose of grinding two-dimensional profiles were very few, and to the author's knowledge no British machine tool manufacturer was represented in the field, the best examples being of continental make.

Machines were based upon mechanical and optical principles, singly or in combination, but all made use of a large master from which a proportional reduction was copied.

In some cases the master consisted of an enlarged drawing, in others of an enlarged metal template. Both those methods have their peculiar shortcomings, but in the case of the latter, particularly where small quantities only are involved, the time required to produce the master was often as great as that required to produce the actual job. The Royal Small Arms Establishment, Enfield, was among those who arrived at that conclusion and about 1935 they approached the author's company in order to obtain a machine which would be capable not only of working from an enlarged master, but also of generating geometric forms directly from basic data.

As a result a machine was designed, and subsequently a number were built, of the type described by the author (1948 "Proceedings," I.Mech.E., Vol. 158, page 84), which could be regarded as the forerunner of the machine with which the present paper is particularly concerned.

"GENOPTIC" PROFILE GRINDING MACHINE

The primary requirements of the machine were that it should :

(1) Be independent of copy for the production of geometric forms.

(2) Work from a photographic master for shapes making the use of copy essential.

(3) Reproduce forms, under mechanical or manual control, by :

(*a*) Gyratory methods.

(*b*) Translatory methods.

(4) Have accurate measuring devices embodied as self-contained and permanent features.

(5) Be capable of automatic operation, in certain instances, by the addition of an optical pick-up.

(6) Be capable of accurate and economic fabrication.

Items (2), (4), (5) and, to some extent (6), indicated that an optical projection system should replace the pantograph of the earlier design, but that it must be free from the shortcomings of optical projection systems previously described in this paper, with regard to both "coverage" and freedom from optical interference.

For accuracy and simplicity the generating mechanisms should use a common system of scales, and this was facilitated by the adoption of optical scales used in conjunction with the projector. Freedom from optical interference is achieved by eliminating the grinding wheel from the projection system, but this and also the subject of coverage will be dealt with fully later on.

Definitions : (a) *Gyratory Grinding.*—This term is used for the method of grinding in which, with arcs of circles, the work will always be presented radially to the grinding wheel and in inclined grinding, for example, in form tools, the angle will be constant in any radial plane.

(b) *Translatory Grinding.*—This term is used for the method of grinding in which, in arcs of circles, the work will maintain the same angular relationship to the grinding wheel, and in inclined grinding the result will be a constant cross section; the angle will decrease pro-

* Institution of Mechanical Engineers, October 27th. Abstracts.

† Head of mechanical development, Taylor, Taylor and Hobson, Ltd.

gressively from a maximum where the grinding wheel is radial to zero at 90 deg. thereto.

Construction.—To avoid optical interference between the image of the work and the grinding wheel, at all times, the actual grinding wheel must have no part in the projection system; this necessitates representation of the outlines of the various grinding wheels by graticules. The avoidance of interference is also largely responsible for the lay-out of the machine in which three elements are linearly disposed in a common slide member, and geared together with a velocity ratio of unity so that linear or angular displacements of one must produce identical conditions in the other two. One element is associated with the grinding head, the second with the generative mechanism, and the third with the optical projection system.

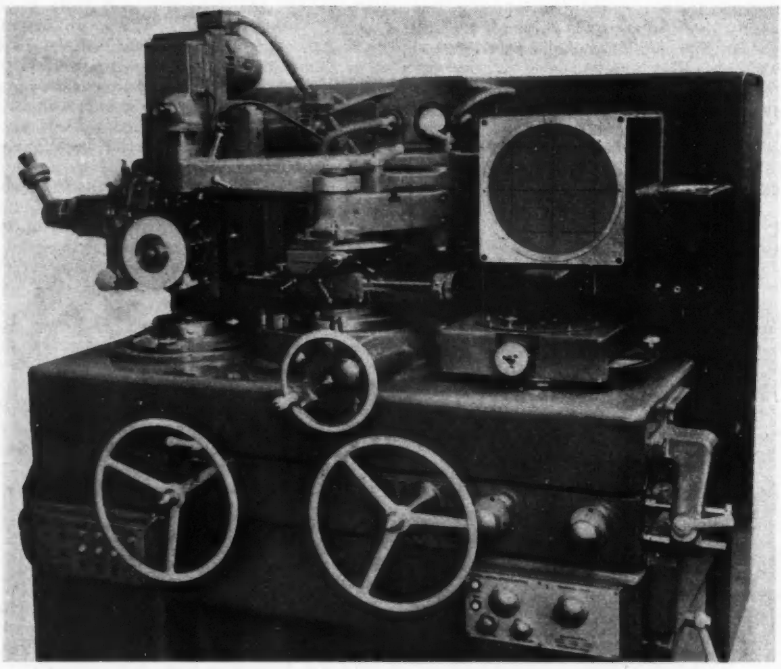
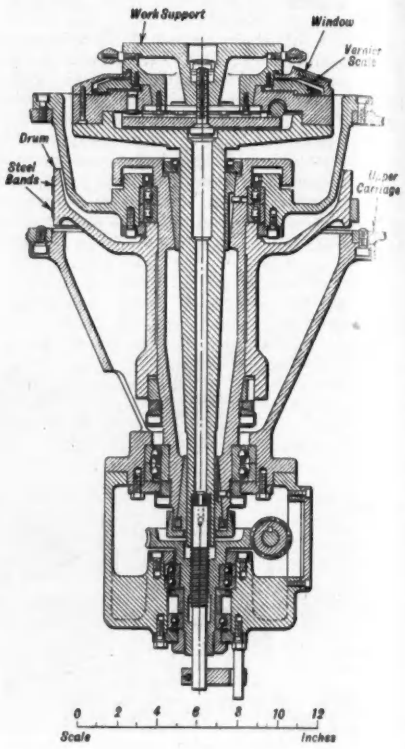


FIG. 1—*"Genoptic" Profile Grinding Machine*

The machine is illustrated in Fig. 1. The construction is as follows:—Two carriages, movable in mutually perpendicular directions, are supported upon a base casting which also carries a grinding head, an adjustable linkage, and a viewing screen. Housed



Section through *A* in Fig. 2

FIG. 3A—*Support for Work*

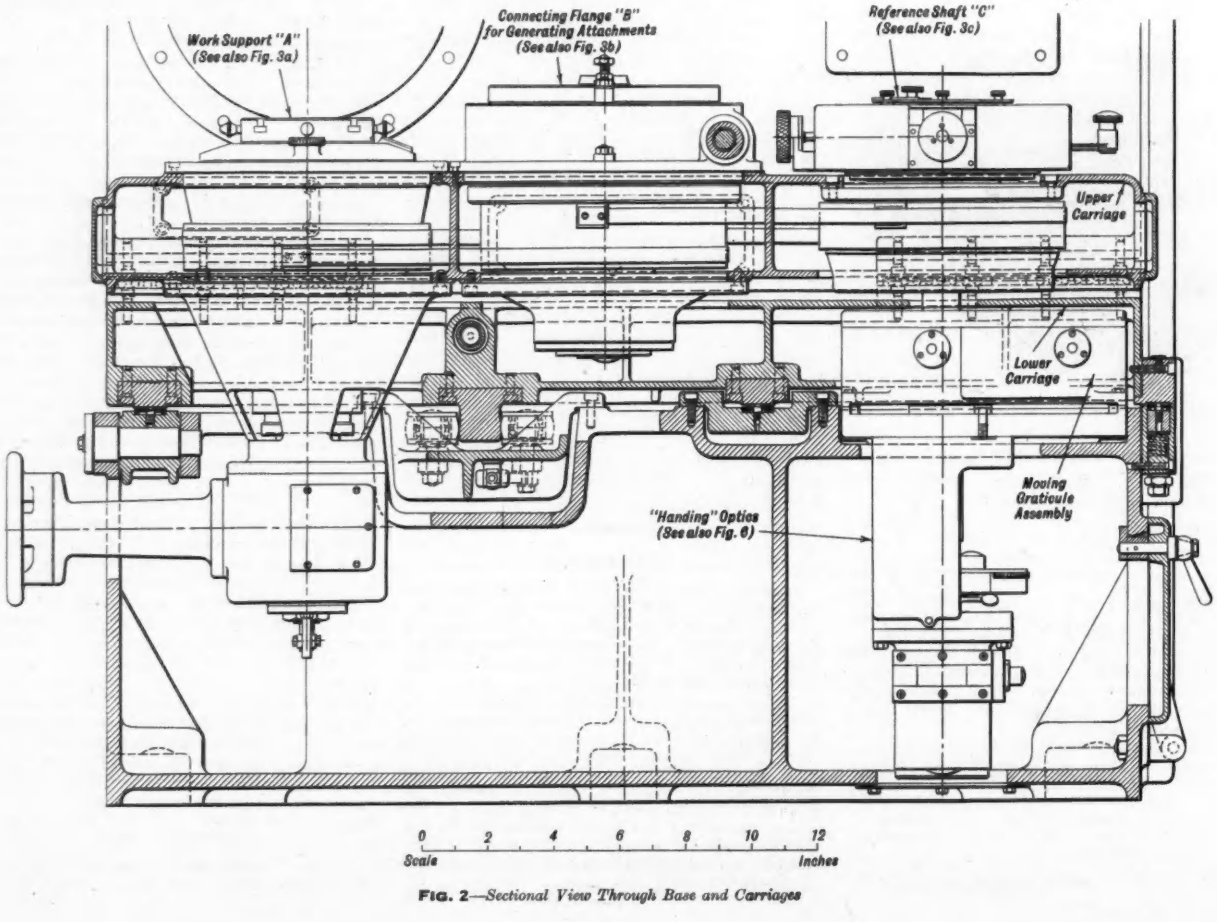

Work Support "A" (See also Fig. 3a)
Connecting Flange "B" for Generating Attachments (See also Fig. 3b)
Reference Shaft "C" (See also Fig. 3c)
Upper Carriage
Lower Carriage
Moving Graticule Assembly
"Handing" Optics (See also Fig. 6)
0 2 4 6 8 10 12
Scale
Inches

FIG. 2—*Sectional View Through Base and Carriages*

in the upper part are three rotatable mechanisms *A*, *B* and *C*, Fig. 2, geared to rotate with a velocity ratio of unity. To avoid possible cyclic errors in rotation, steel bands and drums are used in place of toothed gears. The carriages may be moved under the control of the two large handwheels or may be freed therefrom when required for generative purposes. All movements of the carriages are made with reference to a system of scales or to the photographic copy, optically projected on the viewing screen.

The grinding wheel is carried upon a reciprocating slide with adjustable stroke, a slide to compensate for wheel wear and "arcal" slides to provide clearance angles if required. It is also provided with a small amount of adjustment, in a direction parallel to its axis of rotation, to cover variations in wheel positions when using a selection of mounts. The operative position of the wheel is defined by cross lines in the work microscope, which is fixed.

Fig. 2 shows the method of mounting the carriages, and the means provided for ensuring synchronous rotation of *A*, *B* and *C*.

The respective purposes of *A*, *B* and *C* are as follows:—To support the work by means of a fixture or other device, to support the radius, involute, or other generating devices, and to support the grid scale and copy. The upper carriage is supported upon vee and flat ways with interposed roller bearings, the lower, upon three horizontal ways with interposed roller bearings, the right-hand track being spring loaded to secure approximately equal loading of the three tracks. The guide track is formed by a robust tongue piece working between two pairs of large diameter rollers, one pair being spring urged into contact with the tongue. An advantage of using rollers, large in diameter with regard to the linear movement of the carriage, is that the effect of slight eccentricities is further reduced because of the small angle through which the rollers turn.

Figs. 3A, B and C show sections through *A*, *B* and *C* respectively. Keys have been completely avoided in the interests of accuracy. Spring collars are used to hold the drums rotationally.

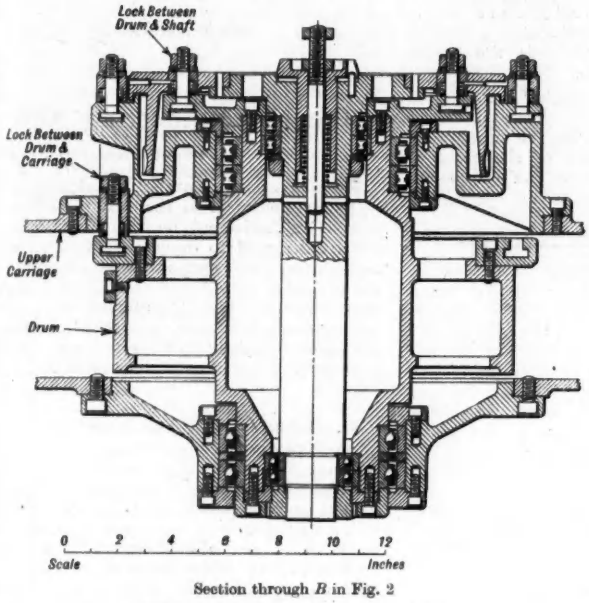
A face plate is provided at *A* as a work support, and a small amount of axial adjustment is provided. *B* embodies the means of freeing the control shaft from its drum and of locking the drum to the carriage when necessary. When the shaft and the drum rotate as a unit, gyratory methods of control apply. When the shaft rotates relative to the drum—the latter being locked against rotation—translatory methods of control apply. At *C* the method of mounting the grid graticule may be more clearly seen. The radial screws with fine-pitched threads facilitate centring the intersection of the median lines of the grid truly in line with the mechanical axis of rotation of the particular assembly. The grid is a fixture in this position and the purpose of the anti-friction slides above it is to facilitate precise adjustments, translational and rotational, in the position of the photographic copy with respect to the grid scale.

The design of the large diameter shallow bearing is interesting; two rows of balls perform separate functions, the upper securing axial location and the lower journal location.

The grinding wheel shown in Fig. 1 as already explained, is carried by a reciprocating slide which can be tilted in the vertical and horizontal planes to provide cutting clearance for form tools. The grinding wheel is disposed so that, irrespective of the angle of reciprocation, the grinding point always passes through the intersection of the above axes. The plane containing the intersection will then also represent the focal plane of the wheel reference or work microscope, as will be shown later.

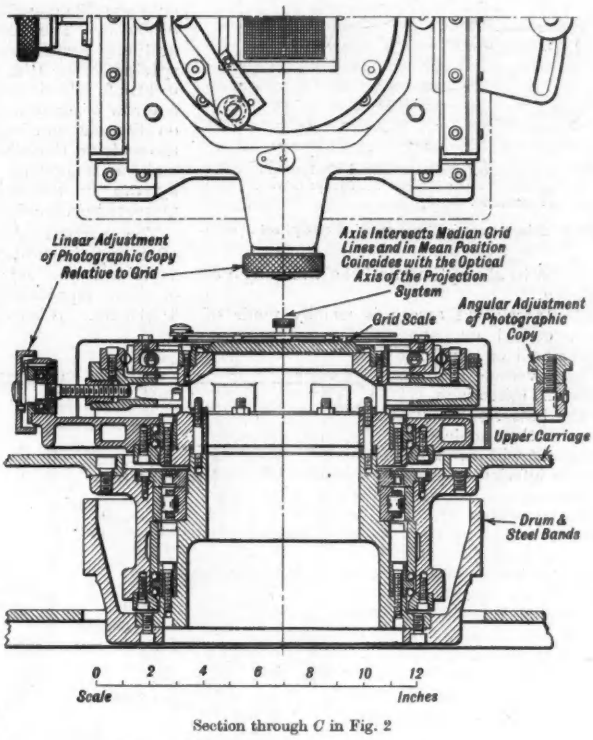
To the right of the grinding head is the adjustable linkage, the purpose of which is to confine to a particular position in space the slide of the radius, involute, or other attachment after this position has been defined by measuring devices in the machine. On the extreme right is the viewing screen.

A fundamental geometrical requirement is that the linear separation of the optical reference or wheel microscope and the image of the fixed graticule upon the screen shall be exactly equal to the linear separation of the axis of rotation of the work and the reference axis (*A* and *C* respectively).



Section through *B* in Fig. 2

FIG. 3B—*Support for Generating Attachments*


Linear Adjustment of Photographic Copy Relative to Grid
Axis Intersects Median Grid Lines and in Mean Position Coincides with the Optical Axis of the Projection System
Grid Scale
Angular Adjustment of Photographic Copy
Upper Carriage
Drum & Steel Bands
0 2 4 6 8 10 12
Scale
Inches

Section through *C* in Fig. 2

FIG. 3C—*Support for Grid Scales and Copy*

Optical System

Certain disadvantages of optical projection have already been mentioned, and the method of overcoming one of the more serious—interference between the projected images of the grinding wheel and of the work—has been described.

Other disadvantages are the necessity to provide a considerable light path within the dimensional limits of a practical machine, and to provide a form of illumination satisfactory both in quality and capacity.

The source of illumination must be of high intrinsic brightness which is also reasonably uniform over the whole of its area. Tungsten-filament lamps are therefore not particularly suitable, better forms being the carbon arc and the high-pressure mercury-vapour discharge lamp.

In the latter case the lenses require correction for chromatic aberration because of the large proportion of blue-green light emitted.

To project an object d inches diameter at a magnification m will require a screen md inches in diameter. In the "Genoptic" machine $d=3\times\sqrt{2}=4\frac{1}{4}$in, $m=40$, giving a screen diameter of 170in, which is obviously impracticable. To illuminate such an area for practical use under normal conditions of workshop lighting would also be impracticable. It was decided, therefore, to concentrate the illumination over a $0\cdot30$in diameter field and to project the area bit by bit using a system of scanning, thus giving a screen diameter of $0\cdot30\times40=12$in.

For all practical purposes the length L of the light path, or, as it is sometimes called, the "throw," will be equal to the sum of the distances separating the object and image from their respective foci, plus twice the focal length of the lens. Thus, if

x=distance between object plane and point of focus

and

x'=distance between image plane and point of focus

then

x=focal length of lens$/m=f/m$

and

$x'=m\times$focal length of lens$=mf$

$$L=f\left(2+m+\frac{1}{m}\right).$$

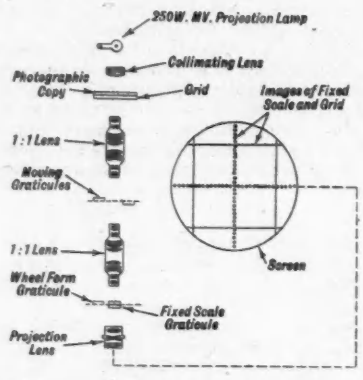
This applies to a single system comprising one complete lens; it is, of course, true for the "Genoptic" machine in so far as it is applicable to the system; it is included here mainly as an illustration.

The method of scanning adopted not only solves the illumination problem, but also makes possible the use of a short-focus projection lens without sacrificing overall capacity; it also ensures that L is a practical quantity.

Projection Screen.—For this there are two alternative materials from which to choose: (*a*) opaque and (*b*) translucent.

The opaque screen of white material has superior diffusing properties, being sufficiently good for both eyes to receive images of similar intensity, even with short-range viewing. It

has, however, the disadvantage that it must be viewed from the same side as the projection lens. Other factors to consider are the loss of light due to absorption, and the wide angle of diffusion.

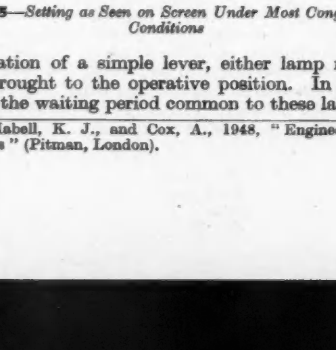


With the exception of the grid and photographic copy the optical system is fixed with respect to the base of the machine.

FIG. 4—*Diagrammatic Representation of Optical System*

The translucent screen is usually made of glass, etched on one side by acid or grinding to an average roughness of 20 micro-inches‡ for the best results, although the angle of diffusion will in any case be inferior to that of the opaque screen. Performance can be improved by using two layers, spaced apart by about 0·005in, the inner layer having a comparatively slow translatory movement in a circular path with respect to the outer one. The main advantages of the translucent screen, however, are two; first, it operates with a lower light value of the illuminant; secondly, it is viewed from the side opposite to the projection lens.

Constituent Elements of the Optical System.—These are shown diagrammatically in Fig. 4. The light source consists of a 250W mercury-vapour projection lamp. Although only one lamp is used at any one time, two lamps are mounted in tandem and adjusted so that, by operation of a simple lever, either lamp may be brought to the operative position. In this way the waiting period common to these lamps if switched on when warm can be reduced. Double chromium-plated shields were used to prevent transmission of heat to the base casting and were found to be very effective.



Circle represents edge of grinding wheel, tangential line represents part of photographic copy.

FIG. 5—*Setting as Seen on Screen Under Most Congested Conditions*

‡ Habell, K. J., and Cox, A., 1948, "Engineering Optics" (Pitman, London).

The copy consists of a photographic outline on transparent material such as glass, and would only be used where generative methods were not possible. It might also be used in combination with generative methods and particularly as an assurance or checking device during the operation of the machine. It is normally located in the plane of the grid scale.

The grid graticule measures 3in by 3in and is ruled in 0·10 squares, to an accuracy of ±0·00005in between adjacent or extreme lines, on a suitable glass disc, the width of line being 0·0005in. The fixed scale consists of two mutually perpendicular rows of circles with a spacing of 0·01in and a clear aperture of 0·0015in. The inclined scales each contain one row of circles, as specified above, the scale on the one graticule being perpendicular to the scale on the other, but rotated as a pair to make an angle with the fixed scale represented by $\tan \theta = 0{\cdot}01/l$in, where l is the length measured on the fixed scale.

The aperture method of setting was adopted after experimentation which proved it to be superior to methods involving the superposing of lines, repeatability being of the order of 0·00005in. Clear apertures of 0·0009in, 0·0011in, 0·0013in and 0·0015in were tried, and with the resolving power of the optics employed, circles below 0·0013in tended to merge into the lines; lines finer than 0·0005in showed distinct evidence of discontinuity and lack of opacity.

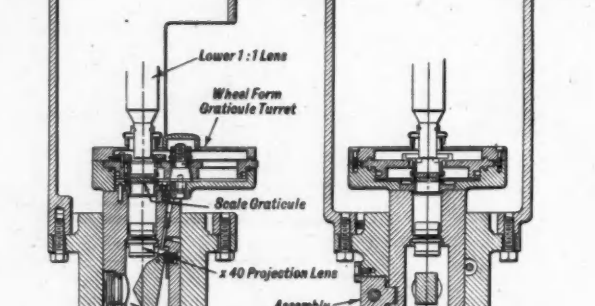


FIG. 6—*Graticule Projection Lens and "Handing" Optics*

The graticules are mounted in pairs with their functional faces adjacent, but separated by about 0·001in. This means that in a system in which the lens precedes the graticules the centre of this space will represent its image plane, and that in one in which the lens follows the graticules the centre of space represents the focal plane, while the depth of focus of the lens must embrace the two functional faces. The light source and lens system are fixed relative to the base of the machine, as are the fixed scale and wheel form graticule.

The grid is mounted as in Fig. 3c, and moves with the upper carriage relative to the fixed optics; the copy when used is normally movable with the grid, but may be adjusted relative thereto by screws. The inclined graticules are mounted upon anti-friction slides and may be introduced into the optical field or withdrawn by manipulation of suitable controls. Another advantage is that the overall length of the inclined scales and fixed scale is contained within the diameter of the optical field.

A selection of wheel-form graticules is mounted in a rotatable turret and any one of them may be brought into the field as required. The turret also contains a plain station so that when generating methods are employed, congestion on the viewing screen may be reduced. Fig. 5 shows a setting as seen on the screen under the most congested condition. It is rare that the fiducial scales would be wanted at the same time as the wheel form and photographic copy.

Fig. 6 is a view through the turret and handing system used in order correctly to relate the direction of movement of the work with that of the appropriate images. It also houses the ×40 projection lens. In optical assembly the inclined graticules represent the datum plane on which a 1/1 lens on either side is focused; the grid is then related to the upper 1/1 lens and the fixed and wheel-form graticules to the lower 1/1 lens. Finally, the ×40 projection lens is focused on fixed-scale and wheel-form graticules and on the images of the grid and inclined scales by the inclined slide. Whenever necessary, centring devices are incorporated in the graticule mounts.

(To be continued)

French Engineering News

(From our French Correspondent)

There is a possibility that the closing of coal and ore mines will in the future have to be ratified by Parliament, because of a Communist motion designed to impede such closures. A Communist report states that seventy pits have already been closed and closing of a further twenty-five is likely. This figure is thought to be exaggerated, however, and it is thought that Parliament is likely to take into consideration technical and social conditions regarding future closures.

* * *

Several thousand workers in privately owned locomotive repair shops working for the French railways are expected to be dismissed before the end of the year. It is also expected that several more shops will be closed by December, owing to the drastic reduction in orders from the S.N.C.F. Out of forty-seven shops working for the railways fifteen are now without orders and six are already closed. It is hoped, however, to adapt the shops for other work, though this will take some time. Parliament will probably discuss the problem and Deputies will ask the Minister of Transport and Public Works to instruct the railways to give less repair work to its own shops.

* * *

On September 1st of this year the French merchant fleet totalled 670 ships with a total tonnage of 2,733,633 tons. This figure does not include eight ships totalling 43,997 tons under construction and fourteen ships totalling 715,295 being laid down in French shipyards and abroad.

* * *

Reporting on the first eight months of 1950, the nationalised French coal mines, the French Coal Board states, produced 34,630,000 tons of coal. That figure was 525,000 tons below production for the same period in 1949. Coke production for the first eight months of 1950 was 2,455,000 tons against 2,470,000 for the same period last year, and gas production was 1,033,000 cubic metres against 1,054,000 cubic metres.

The output per miner continued to improve, passing from 1135kg in January to 1210kg in July, against a mean of 1095kg last year. Production costs went up, however, owing to salary increases, and the increased output was not sufficient to meet the higher costs. In 1949 production costs were 3327 francs per ton, against 3356 francs during the first eight months of this year.

* * *

A new research laboratory has been opened by the Charbonnages de France at Verneuil. It will study, in particular, how to make better use in industry of coal and coke; the wear of cables, and the behaviour of damp gas will be amongst the subjects investigated by the laboratory.

Industrial and Labour Notes

Wage Claims

At the beginning of this week it was stated that the National Arbitration Tribunal was meeting to consider the dispute over a wage claim between the Engineering and Allied Employers' National Federation and the Confederation of Shipbuilding and Engineering Unions. It will be recalled that for many months past engineering and shipbuilding wages have been under negotiation and discussion by employers and unions.

Since the rejection, early this year, of the claim for an all-round increase of £1 a week, and the subsequent ballot taken by the unions the Employers' Federation has made an offer of increases ranging from 8s. a week for unskilled workers to 11s. for craftsmen. But, after discussion, the Confederation decided a month ago that it could not accept the employers' offer, and referred the original claim to the Minister of Labour for consideration by the National Arbitration Tribunal.

Other wage claims in dispute are those put forward by the three railway unions. The Associated Society of Locomotive Engineers and Firemen asked for an increase of 15 per cent, the National Union of Railwaymen for an increase of 10 per cent, and the Railway Clerks' Association for an increase of 7½ per cent. All the claims were rejected by the Railway Executive and the dispute subsequently reported to the Minister of Labour. The Railway Staff National Council is now considering the matter. The three railway unions are represented on the Council, as well as the Railway Executive.

Iron and Steel Arbitration Tribunal

The Ministry of Supply announced at the end of last week that the Iron and Steel Arbitration Tribunal had been set up as required by Section 43 of the Iron and Steel Act. The legal member and President of the Tribunal (except in Scottish proceedings) is Sir John Howard, formerly Legal Secretary of the Ceylon Government, and Tribunal members for all proceedings are Sir Frederick Alban and Mr. E. C. Ellen. Mr. Douglas A. Mortimer will serve as legal member and President in Scottish proceedings.

The Tribunal will hear and determine any questions, disputes or other matters which may be referred to arbitration under the Iron and Steel Act. As an example, it will determine, failing agreement between the Minister of Supply and a stockholders' representative, the value for compensation of any security which vests in the Iron and Steel Corporation of Great Britain, which was not quoted on the Stock Exchange at the material dates under the Act.

Industry in the London and S.E. Region

One of the matters reported at a meeting, last week, of the London and South-Eastern Regional Board for Industry was a serious shortage of strip and sheet steel, zinc, and paper board. It was stated that reports reaching the Ministry of Supply showed that many firms in the region were faced with serious difficulty in obtaining deliveries of cold rolled strip, demand for and consumption of which have risen steeply from the 1949 level. The Board heard also that the shortage of zinc was assuming serious proportions. It was reported that zinc consumers view with considerable alarm the repercussions to be expected from the rationing of supplies to nine-tenths of the average monthly consumption in 1949.

So far as export business is concerned in the London and South-East Region, it was reported that interest in the dollar markets had increased, and the Board of Trade considered that the concrete results of the "strenuous exhortations" of the past few months were now becoming apparent. Many firms not hitherto engaged in exporting to the dollar markets were seeking advice and information on the possibilities. Another matter, which was brought to the notice of the Regional Board by the Ministry of Supply was that many industrialists were unaware of the facilities available in the New Towns. It was urged that a more effective publicity campaign should be undertaken. Finally, it was stated that the conclusions drawn from a Board of Trade study of industry and employment in the Medway area were that the introduction of firms new to the area had given rise to employment demands exceeding the surplus created by the removal of Short Brothers, Ltd., to Northern Ireland. Future plans, it was noted, would involve increased labour demands, including those of the dockyard and the Anglo-Iranian oil refinery on the Isle of Grain.

Index of Industrial Production

The Economic Information Unit of the Treasury has now published a statement on the interim index of industrial production for the month of August. The index number (1946=100) has been estimated, provisionally, at 125 for August, for all industries, compared with 134 for July. Last year the numbers for the corresponding months were 119 and 118 respectively. It is pointed out, of course, that the figures for July and August every year are affected by annual holidays.

The Economic Information Unit says that, on the basis of information which has now been received, the index number for September, for all industries, is expected to be 142 or 143. In 1949 it was 132. It is added that the increase in industrial production of 8 to 9 per cent over a year earlier was maintained in the third quarter of 1950, according to the provisional figure for August and the estimate for September.

Non-Ferrous Metals

On Monday last, the Minister of Supply, Mr. Strauss, answered questions in the House of Commons on the price of zinc and on the export of copper. The Minister was asked to what extent he had recently had to pay more for zinc on the Continent than the price at which it was sold to consumers in this country. His answer was that it would be contrary to established practice to disclose contract prices. The Minister was also asked if the zinc allocation to Royal Ordnance Factories was restricted to 90 per cent of their 1949 intake in the same way that zinc allocations to the rest of industry were now restricted. In reply to that Mr. Strauss said that the demands of the Royal Ordnance Factories for zinc for defence work would be met in full, but for civilian work the factories would be treated in the same way as commercial manufacturers.

The question about copper asked if the Minister was aware of the sudden demand from unusual export markets, and what steps he was taking to keep the metal in the country for the use of our finishing industries. The Minister said that he was aware of the demand, but pointed out that the export of copper and copper scrap, except under licence, was prohibited. Licences were granted exceptionally for the export of very small quantities of unwrought copper, and exports, under licence, of copper alloys in ingot form were restricted, by arrangement with the trade, to a quota based on exports in 1949. The Minister added that since September 11th, exports of semi-manufactures of copper, except under licence, had also been prohibited. Licences were granted for export to traditional markets, notably the Commonwealth countries, but the extent of those exports was now being reviewed.

Trade Union Membership

A statistical summary of registered trade unions in Great Britain, which has been compiled from the returns made under the Trade Union Acts, has just been published by H.M. Stationery Office. It covers the years 1939 to 1949, and shows that at the end of last year there were 417 registered trade unions with a total membership of 7,883,736. At the end of 1939 there were 424 unions with an aggregate membership of 5,018,968. The summary shows also a membership decline in 1949, compared with 1948. The returns for 1948 covered 416 unions with an aggregate membership of 7,916,564. Incidentally, the number of registered unions last year in the metal, engineering, shipbuilding and vehicles industrial group is given as sixty-nine, with an aggregate membership of 1,631,361.

An introductory note to the summary, by Sir Bernard Kerr White, Chief Registrar of Friendly Societies, says it is estimated that the membership of the registered unions of employees now represents about 90 per cent of that of the whole of the trade union movement of Great Britain. The registered employers' associations, on the other hand, form only a small proportion of the total number of such associations known to exist, and, in general, are probably not the most important of them. The registered employers' associations at the end of 1949 numbered ninety-six, with an aggregate membership of 116,021.

A Rearmament Advisory Committee

At a meeting of the National Production Advisory Council for Industry, held on Friday last, under the chairmanship of the Chancellor of the Exchequer, it was decided to set up a special rearmament sub-committee. From an official statement on the matter, it seems that the business of the sub-committee will be to discuss with the Ministers concerned the general economic and industrial problems arising from the defence programme. It is stated that the sub-committee will be small in number and will meet informally as required. The sub-committee, it appears, will provide contact between Ministers and industrial leaders on broad questions only. The Regional Boards for Industry, the Scottish Board for Industry and other organisations already in existence give facilities for consultation on most matters concerned with the carrying out of the rearmament programme.

Iron and Steel Production

The October figures for British steel production, which were issued on Wednesday morning, show that the weekly average output of ingots and castings was 327,700 tons, a figure indicating an annual output rate of 17,040,000 tons. The British Iron and Steel Federation points out that this is the highest annual rate ever achieved in the month of October. In fact, the steel production rate has only exceeded the 17,000,000-ton mark once before, in March last, when output was at an annual rate of 17,147,000 tons.

Pig iron output during October averaged 193,900 tons a week, and was thus at an annual rate of 10,084,000 tons. A year ago the annual production rate for pig iron in this country was 9,565,000 tons.

Valve Manufacturing Team for U.S.A.

Under arrangements made by the Anglo-American Council on Productivity, a team representing the steel, iron and non-ferrous valve-manufacturing industry of this country left on November 7th for a visit to the U.S.A. It may be mentioned that the team, which is being led by Mr. K. M. Leach, managing director of the Audley Engineering Company, Ltd., is an unusually youthful one, the average age of its fifteen members being only thirty-six.

It is recognised that the wide variety of the valve industry's products will make comparisons of productivity difficult in the U.S.A. But, like teams from other industries, this one is to study such matters as factory administration and lay-out, materials handling, machining, assembly, utilisation of labour, techniques and machinery, and indeed any practices which differ from those in the valve-manufacturing industry of this country.

Personal and Business

MR. A. J. KIRK has joined the staff of the Industrial Department of Philips Electrical, Ltd.

MR. F. J. EARNSHAW, A.M.I.E.E., has been appointed a director of the Plessey Company, Ltd., Ilford.

LIEUT.-COLONEL R. L. BENSON has retired from the board of Automatic Telephone and Electric Company, Ltd.

C. A. SALE AND CO., Ltd., states that its new address is 9, Park Hill, Clapham, S.W.4 (telephone, Macaulay 3526).

MR. W. F. BUTLER, secretary of W. Sisson and Co., Ltd., Gloucester, had been appointed a director of the company.

MR. G. M. RITCHIE has joined the research and development division of the British Steel Founders' Association in a senior executive capacity.

MR. D. M. STEEL has been appointed chief technical engineer of the Renfrew works of Babcock and Wilcox, Ltd., in succession to Mr. T. W. Pollock.

MR. J. SINGLETON-GREEN, M.Sc., A.M.I.C.E., has been appointed managing director of Stressed Concrete Design, Ltd., 46, Great Marlborough Street, London, W.1.

EUMUCO (ENGLAND), Ltd., Beverley Works, Barnes, S.W.13, states that it is now wholly owned by Lamberton and Co., Ltd., Coatbridge. Mr. P. Granby has resigned from the board.

KEITH BLACKMAN, Ltd., Tottenham, N.17, states that Mr. D. S. Woodley, A.M.I.Mech.E., technical director and chief engineer, has been appointed deputy chairman of the company.

MARSHALL SONS AND CO., Ltd., Gainsborough, announces the resignation of Mr. George Bryden from the position of managing director. Mr. Edward Burgess has been appointed to succeed him.

THE BRITISH STANDARDS INSTITUTION has opened a branch office at 12, Hilton Street, Manchester, 1 (telephone, Central 4856), in charge of Mr. A. F. B. Nall, an assistant technical director of the Institution.

G. AND J. WEIR, Ltd., Glasgow, announces the appointment of Mr. Forrest T. Randell as manager of its Cardiff office and representative in South Wales and the West of England, in succession to the late Mr. F. C. Williams.

PROFESSOR R. O. KAPP, M.I.E.E., has joined the firm of Messrs. Kennedy and Donkin, 12, Caxton Street, London, S.W.1, as a consultant, on his retirement from the Pender Professorship of Electrical Engineering, University College, London.

MUREX, Ltd., announces the formation of a new company known as Murex (Australasia) Pty., Ltd. The head office of the company, together with a modern factory and research department, is to be situated at Derwent Park, Hobart, Tasmania.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby, announces the following appointments: Mr. L. Drucquer, M.I.E.E., manager, home sales (plant and apparatus), and Mr. P. E. Gaze, A.M.I.E.E., manager, switchgear sales department Willesden.

VICKERS, Ltd., announces that, following the appointment of Jack Olding and Co., Ltd., as sole world distributor of the Vickers Industrial tractor, arrangements have been made under which two of its directors serve on the board of Jack Olding and Co., Ltd. The first two to be so appointed are Mr. J. Reid Young and Major-General C. A. L. Dunphie.

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, Ltd., announces the establishment in Mombasa of an inspectorate providing radio and radar maintenance facilities for vessels calling at ports in the area. The address of this new inspectorate is c/o. Smith, Mackenzie and Co., Ltd., Kilindini Road, Mombasa (telephone, Mombasa 2451, extension 17).

THE SIMON ENGINEERING GROUP, Cheadle Heath, Stockport, announces that Mr. A. H. Bennett has been appointed a director of Turbine Gears, Ltd., of which company he is general manager. Mr. J. G. MacLean and Mr. N. Ramsey have been appointed directors of Henry Simon (Engineering Works), Ltd., of which company they are general manager and commercial manager, respectively.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., announces the following appointments: Mr. L. C. Richards, M.I.E.E., chief engineer, transformer department, in succession to Mr. A. G. Ellis, who, after thirty-two years' service, has now become consultant to the department; Mr. R. M. Watts, superintendent, steel products department, in succession to Mr. T. Dooley, who has transferred to the Hotpoint Electric Appliance Company, Ltd.

Notes and Memoranda

Air and Water

HOPPER BARGE.—Brooke Marine, Ltd., announces that it has completed a 250-ton hopper barge for export to Australia. It has been prefabricated in fifty-six units of all-welded construction, and of 5 tons maximum weight, which will be assembled by riveting.

OCEAN SHIPPING PLANNING BOARD.—Three senior officials of the Ministry of Transport have sailed for the United States to attend meetings of the Planning Board for Ocean Shipping under the North Atlantic Treaty Organisation, and will discuss shipping matters with the Canadian Government before proceeding to Washington.

THE COLLEGE OF AERONAUTICS.—The Board of Governors of the College of Aeronautics has established a Chair in Aircraft Structures and Aero-Elasticity in the Department of Aircraft Design. Mr. W. S. Hemp, M.A., A.F.R.Ae.S., formerly Senior Lecturer in Aircraft Structures and the Deputy Head of the Department, has been appointed to the Chair. He joined the staff of the College in September, 1946.

LLOYD'S REGISTER WRECK RETURNS.—Lloyd's Register of Shipping statistical summary of vessels of 100 tons and upwards totally lost or broken up during 1949, shows that 219 ships, totalling 236,690 tons gross, were lost due to casualty or stress of weather, including 216 steamers and motorships, amounting to 235,330 tons gross, of which twenty-five ships, representing 63,868 tons gross, belonged to Great Britain and Northern Ireland. Ships broken up through causes other than casualty or stress of weather totalled 621,971 tons gross, representing 195 ships, of which 191 were steamers and motorships of 617,761 tons gross. Of these, eighty-six ships having a total of 264,438 tons gross were owned in Great Britain and Northern Ireland. The gross reduction in the world mercantile marine from all causes was 414 ships, representing 858,661 tons gross.

AIR TRAFFIC.—Air traffic at United Kingdom aerodromes during August, 1950, was the heaviest ever recorded, there being a total of 27,432 landings and take-offs of aircraft on air transport flights during the month. This represents an increase of 8·8 per cent, compared with August, 1949, and the total number of commercial passenger movements was 346,736, an increase of 13·7 per cent. The tonnage of freight on and off-loaded increased by 24·2 per cent to a total of almost 3639 tons. Nearly 107,000 passengers used Northolt Airport, whilst London Airport handled nearly 60,300 and the two airports together handled 48·2 per cent of the total commercial passenger movements recorded. The third busiest terminal in the United Kingdom in August was Ronaldsway, which handled 23,440 commercial passengers; Glasgow handled 21,812, and at Jersey Airport 40,011 passenger movements were recorded.

Miscellanea

MOBILE DIESEL INSTRUCTION SCHOOL.—Produced by F. Perkins, Ltd., of Peterborough, the first of five mobile diesel instruction schools has left for Canada, the others being destined for Australia, India, South America and Europe. The school is intended to spread general service and maintenance knowledge of the diesel engine overseas and from it instruction can be given to an audience of 400.

REVIEW OF THE TORONTO FAIR.—The Engineering Industries Association has issued a booklet entitled "Canada—a Market with Prospects," which reports on the value of British participation in the 1950 Toronto Fair. It may be recalled that the Association organised a joint exhibit by means of which the products of more than eighty of its member firms were displayed. The report makes a full survey of the Association's experience as an exhibitor at the Fair, commenting, at the same time, that "a market exists in Canada, but it requires positive action on the part of the manufacturer if he is to obtain a share of it."

BACK PRESSURE TURBO-GENERATOR SETS FOR MORWELL, AUSTRALIA.—Two 30MW 3000 r.p.m., back-pressure turbo-generator sets, recently ordered from the Metropolitan-Vickers Electrical Company, Ltd., by the State Electricity Commission of Victoria, are destined for the new power station at Morwell, in the Yallourn opencast coal-mining area. These sets and three similar machines already under construction at Trafford Park, will feed the Commission's 11kV network and the exhaust steam from the turbines will be used for drying crushed coal for briquette making. The turbines will be single-cylinder machines, working with inlet steam conditions of 1200 lb per square inch gauge, 915 deg. Fah., and exhausting at 28 lb per square inch gauge, with about 20 deg. Fah. of superheat; each will have a velocity-compounded stage followed by fifteen single-impulse stages. The turbines will be supplied with two-stage "super high pressure" feed heating equipment to raise the temperature to 380 deg. Fah., the feed heaters working at the unusually high pressure of 1800 lb per square inch gauge. The turbo-generators, rated at 33,333kVA, will be wound for 11kV and will be air-cooled with closed-circuit ventilation.

"TINPLATE HANDBOOK."—The Tin Research Institute, Fraser Road, Greenford, Middlesex, has just published a "Tinplate Handbook," which has been compiled by W. E. Hoare, B.Sc. (Eng.), F.I.M. It contains a wealth of statistical data and other information which cannot fail to be of service to buyers and users of tinplate. A specially useful section is that which includes an English-French-German-Spanish glossary of the technical terms of the tinplate trade. From the statistics it is of interest to note that world production of tinplate increased from an annual average of 3,762,000 long tons in 1936–39 to 4,488,000 tons in 1949.

VIRGIN ZINC DELIVERIES.—The Ministry of Supply has stated that, owing to the present shortage of virgin zinc it has become necessary to restrict the amounts that can be acquired by consumers in the United Kingdom. Until further notice, consumers are allowed to purchase for delivery each month from the directorate of non-ferrous metals not more than nine-tenths of their average monthly consumption in 1949. The Director of Non-Ferrous Metals will inform all consumers of the amount of their quota, calculated on the returns of consumption in 1949 made to the Bureau of Non-Ferrous Metals Statistics.

CONCRETE PRACTICE.—The Cement and Concrete Association has recently published a booklet of sixty-two pages, entitled "Concrete Practice in Building Construction." It is intended for the use of clerks of works, contractors' agents and others responsible for the supervision of concrete work, and to explain the reasons for the various clauses of specifications. The booklet is well illustrated and covers all the various subjects associated with concrete work and ends with three short chapters devoted to lightweight concrete, air entrainment and prestressed concrete. Copies may be obtained free of charge from the Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—Under the chairmanship of Mr. A. W. Berry, M.I.Mech.E., M.I.E.E., the Faraday House Old Students' Association annual dinner was held on Friday, November 3rd at the Savoy Hotel, London. The principal speakers were Lieut.-General Sir Ronald Weeks, K.C.B., D.S.O., chairman of Vickers, Ltd., and of the National Advisory Council for Education in Industry and Commerce, and Sir Noel Ashbridge, Director of Technical Services, B.B.C. Among the Past-Presidents of the Institution of Electrical Engineers present were the Earl of Mount Edgcumbe, Sir Vincent de Ferranti, Sir Arthur Fleming, and Mr. P. V. Hunter. It was noted with interest that this year's President of the Association, Mr. A. W. Berry, Director of the British Engineers' Association (Inc.), is the third member of the family to hold this office, his father, Mr. A. F. Berry, having been President in 1909, and his uncle, Mr. F. E. Berry, in 1928.

CONFERENCE ON WIRE ROPES IN MINES.—A conference on wire ropes in mines took place on September 19th to 22nd at Ashorne Hill, near Leamington Spa, sponsored by the Institution of Mining and Metallurgy and supported by the Institutions of Mining and of Mechanical Engineers, the National Coal Board, the Ministry of Fuel and Power, British Iron and Steel Research Association, Federation of Wire Rope Manufacturers of Great Britain, Locked Coil Rope Makers' Association, and Winding Engine Manufacturers' Association, under the chairmanship of S. E. Taylor, D.Sc., M.A. The presence among the 250 or so members and delegates of representatives from Belgium, France, Netherlands, Sweden, Norway, Germany, Italy and from South Africa, Australia, Canada, U.S.A., and India gave the conference quite an international complexion. Eighteen papers covering rope making and research winding practice, &c., in Great Britain and in the countries named were presented and elicited valuable discussions. The "Proceedings," with the papers and relevant discussions thereon, are to be published in due course by the institution first named above.

British Patent Specifications

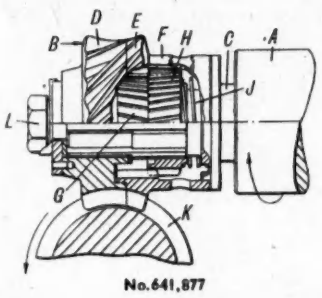
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

INTERNAL COMBUSTION ENGINES

641,877. November 16, 1948.—IMPROVEMENTS RELATING TO GEAR WHEELS, Morris Motors, Ltd., of Cowley, Oxford (*Inventor, Walter James Thomas*).

This invention relates to gear wheels of the kind split into two co-axial parts having their respective sets of teeth angularly displaced, by resilient coupling of the parts, to an extent which is automatically adjustable to eliminate backlash in the drive between the split gear and a co-operating non-divided gear which meshes simultaneously with both sets of teeth of the split gear. The accompanying drawing shows the application of the invention to worm gearing for driving an overhead camshaft *A* of an internal combustion engine. The worm wheel *B*, which is mounted on a portion *C* of the camshaft of reduced diameter, is split into a main part *D*, which is fast on the camshaft, and a juxtaposed narrower subsidiary part *E* integral with a sleeve *F* which is loose on the camshaft and



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abuts against a collar formed on the camshaft portion *C*. The sleeve *F*, the internal diameter of which is materially larger than the diameter of the reduced portion of the camshaft which it surrounds, is formed with an internal helical gear *G* at the end adjoining the split gear. This helical gear co-operates with a ring-like helical gear *H* which is splined to the camshaft so that it is slidable along the axis of the split gear, but cannot rotate relatively to the main part of that gear. The helical gear *H* is acted upon by a fairly light helical compression spring *J*, which encircles the reduced portion of the camshaft and is encased by the sleeve. This spring feeds the helical gear *H* axially into mesh with the internal helical gear *G*, and the resulting angular displacement of the subsidiary part *E* of the split gear *B* causes the respective sets of teeth of this gear to be pre-loaded against the teeth of the co-operating worm *K* meshing with both parts of the split gear. The worm *K* is fixed to a vertical drive shaft, at the crankshaft end of which the gearing shown is duplicated, the split gear assembly being on the drive shaft and its associated worm on the crankshaft. Any further backlash arising in the worm gearing owing to subsequent wear is automatically absorbed by corresponding additional axial displacement of the helical gear *H* producing greater angular displacement of the subsidiary part *E* of the split gear relatively to the main part *D*. The split gear assembly is held in place against the collar by means of a retaining washer and a bolt *L*.—*August* 23, 1950.

WELDING

643,816. April 15, 1948.—IMPROVEMENTS IN OR RELATING TO THE WELDING OF SEAMS IN METALLIC TUBING, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and William Frank Barker and John Robert Spencer, both of the General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

In the course of investigations on the seaming of steel conduit using high-frequency induction heating, the conduit being passed through an inductor coil carrying high-frequency current, the inventors found that if the opposing faces of the conduit come together under the force of pressure rolls to form a "line" contact, heating of the faces was improved. The joint resistance is considerably higher than if the two faces abut together over their whole surfaces and, where the radially inner edges of the faces come into line contact, the welding current tends to concentrate and flow round the outer surface of the conduit and across the opposing faces to be welded together. An object of the invention is the provision of a method of welding the seam in metallic tubing which makes use of this discovery. In order to provide two line contacts between the opposing faces of the seam in the tubing a conducting wire *A* is placed between the faces at their mid-points, and trapped in position by the pressure rolls. Those parts of the tubing where the current density is high and, therefore, the heating is concentrated, are shown shaded in the upper drawing. The opposing faces can also be suitably shaped to locate the wire at about the middle as shown. If desired, the wire can be heated nearly to melting point as it is fed between the

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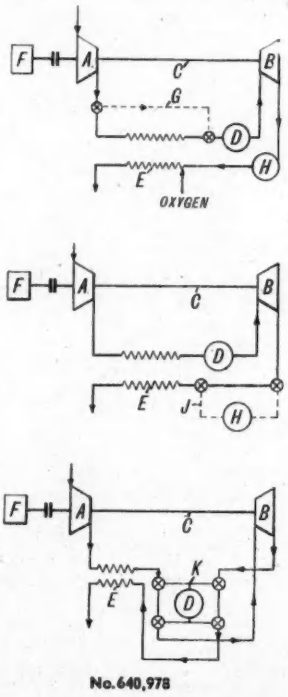
faces. For this purpose a suitable electric potential may be applied between the tubing and the wire. Where a forge weld of the seam in tubing is to be produced by high-frequency induction heating, the forging pressure may be supplied by the pressure rolls or from the differential expansion produced by the fact that only the outer skin of the tubing is heated by the induced current. Such differential expansion can also be used to keep the faces of the seam together if a fusion weld is required. Instead of using a wire, one or both faces of the seam can be specially formed to ensure a line contact. Either one face may have a projecting tapering fin which engages the flat surface of the other face, or both faces may have projecting tapering fins which meet to form a line contact. The fin or fins would be disposed at such a point along the radial thickness of the metal that, after welding, no ridge is left on the inside of the seam.—*September* 27, 1950.

GAS TURBINES

640,978. April 26, 1948.—METHOD OF AND MEANS FOR CLEANING HEAT EXCHANGERS IN GAS TURBINE INSTALLATIONS, Power Jets (Research and Development), Ltd., of 25, Green Street, London, W.1 (*Inventor, James Hodge*).

It is an object of the present invention to enable the cleaning of a heat exchanger in a gas turbine installation to be effected without dismantling the



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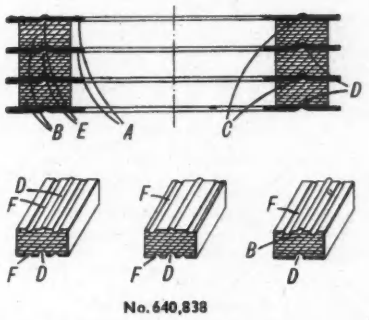
apparatus, and to this end the invention proposes that deposit in the hot fluid passages of the exchanger should be removed by being burnt off at a temperature higher than the maximum allowable temperature at which the heat exchanger may be permitted to operate in working conditions. The accompanying drawings are cycle diagrams showing how the present invention may be performed. Each shows a simple open-cycle gas turbine plant having a compressor *A*, and a turbine *B* on a common shaft *C*, a main combustion chamber *D*, and a heat exchanger *E*. In addition, there is provided an auxiliary motor *F*, which, when it is desired to clean the heat exchanger, is brought into operation and clutched to the shaft *C* to drive the latter at a low speed so as to produce a flow through the system without, however, resulting in a marked pressure difference between the hot and cold sides of the heat exchanger. If desired there may be a by-pass duct *G* with two-way valves at either end which may be set so that the cold side of the heat exchanger is entirely by-passed by the working fluid. In the top arrangement there is a supplementary combustion chamber *H* in the circuit between the turbine and the heat exchanger. To clean the heat exchanger this combustion chamber is brought into operation to heat the working fluid to a high temperature, while combustion is not initiated in the chamber *D*. During normal operation, when the combustion chamber *D* is functioning, the exhaust gases from the turbine pass through the supplementary chamber *H* in which there is then no combustion taking place. In the modification in the middle drawing, the chamber *H* is arranged in parallel with the main circuit, being connected thereto by a branch duct *J* having two-way valves at either end whereby the working fluid may be either by-passed around the chamber or conducted through it. In the lower drawing there is only one combustion chamber, the main chamber *D*, which is connected between the inlet line to the turbine and the outlet line therefrom by a ducting system *K*, and four two-way valves. The valves may be set so that the combustion chamber is either effective upstream of the turbine, for normal working, or downstream of the turbine for cleaning the heat exchanger. In the latter case the admission of fuel to the chamber will be suitably controlled to provide the necessary higher temperature. To obtain more satisfactory burning off of the deposit a connection may be provided (for instance, at the point indicated in the upper view) for the admission of a supply of oxygen from a suitable source. Alternatively, or in addition to such oxygen enrichment, catalytic material may be introduced into the hot side of the heat exchanger to promote the cleaning action.—*August* 2, 1950.

MISCELLANEOUS

640,838. June 15, 1948.—IMPROVEMENTS RELATING TO RUBBER SPRINGS, S.A.G.A. Societa Applicazioni Gomma Antivibranti, of Via G.B Pirelli 1, Milan, Italy.

The drawings show a section through a cylindrical spring composed of annular sheet metal discs alternated in the pile with circular rings of resilient rubber. Perspective sectional views illustrating several alternative forms for the rubber elements of the improved spring of the invention are also given. In the upper drawing the metal discs are marked *A* and the rubber rings *B*. The metal discs *A* are formed with circular ribs *C* disposed concentrically with the inner and outer peripheries of the disc.

These ribs are in axial alignment with one another in the discs composing the pile, and they register with co-operating circular recesses *D* in the rubber



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rings, as shown in the figure. Also in axial alignment with the ribs, on the underside of the discs, are circular depressions in the discs, which snugly fit with co-operating circular ribs *E* in the rubber rings, the ribs *E* being on the upper face of the rings. As shown, the recesses *D* are of considerably larger cross sectional area than the ribs *C*. The depressions on the underside of the discs similarly serve, in conjunction with the ribs *E* on the upper side of the rings, to locate the rings relatively to the discs. The recesses *D*, however, serve the additional purpose, owing to their enlarged cross-sectional area relatively to the ribs *C*, of giving to the ring a higher degree of elastic deformability, or softness, especially in the initial stage of the deformation. In addition, they constitute air cushions. The drawings show constructions, as regards the resilient rubber elements of the improved spring of the invention, in which additional cavities, over and above the cavities formed by the unoccupied portions of the recesses *D*, are provided, the additional cavities being marked *F*. Other arrangements are also shown.—*July* 15, 1950.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Sat., Nov. 18th.—OXFORD BRANCH: Electricity Board's Demonstration Room, George Street, Oxford, "Radio Interference Suppression," 3 p.m.

Mon., Nov. 20th.—CENTRAL LONDON BRANCH: St. Ermins Hotel, London, S.W.1, "Electricity in Agriculture," W. Cover, 6.50 p.m.

British Institute of Management

Thurs., Nov. 16th to Sun., Nov. 19th.—Autumn Management Conference, Harrogate.

British Institution of Radio Engineers

Mon., Nov. 20th.—LONDON SECTION: London School of Hygiene and Tropical Medicine, Gower Street, W.C.1, "Ultrasonic Generators for High Powers," P. E. Noltingk, 6.30 p.m.

Chemical Society

Thurs., Nov. 16th.—Burlington House, Piccadilly, W.1, A Meeting for the Reading of Original Papers, 7.30 p.m.

Diesel Engine Users Association

Thurs., Nov. 16th.—Caxton Hall, Westminster, S.W.1, "Instrumentation as Applied to Diesel Engines," R. J. B. Keig, 2.30 p.m.

Illuminating Engineering Society

Tues., Nov. 14th.—Lighting Service Bureau, 2, Savoy Hill, W.C.2, "The Lighting of the House of Commons," C. Dykes-Brown, 6 p.m.——STOKE-ON-TRENT GROUP: 31, Kingsway, Stoke-on-Trent, "Care and Maintenance of Fluorescent Lamps," A. G. Mitchell, 6 p.m.

Wed., Nov. 15th.—LEEDS CENTRE: Albion Hall, Central Y.M.C.A. Building, Albion Place, Leeds 1, "Radiation, Light and Illumination," J. N. Aldington, 7 p.m.

Thurs., Nov. 16th.—GLOUCESTER AND CHELTENHAM CENTRE: Cadena Cafe, High Street, Cheltenham, "Lighting in the Home," Miss M. Wardlaw, 6.30 p.m.

Incorporated Plant Engineers

Mon., Nov. 13th.—DUNDEE BRANCH: Mathers Hotel, Dundee, "Water and Boiler Efficiency Problems," A. Leekie, 7.30 p.m.——KENT BRANCH: Technical College, Maidstone, "Corrosion Problems," Dr. Gyngell, 7 p.m.

Tues., Nov. 14th.—E. LANCASHIRE BRANCH: Engineers Club, Albert Square, Manchester, "The Application of Colour in Industry," H. L. Gloag, 7.15 p.m.

Wed., Nov. 15th.—LIVERPOOL AND N. WALES BRANCH: Radiant House, Bold Street, Liverpool, "Electronics in Industry," K. Marwood, 7 p.m.——WESTERN BRANCH: Grand Hotel, Bristol, "Engineering Applications of Electro-Deposited Metals," J. W. Oswald, 7.15 p.m.

Institute of British Foundrymen

Thurs., Nov. 16th.—BURNLEY SECTION: Municipal Technical College, Ormerod Road, Burnley, "Non-Ferrous Founding," T. Freeman, 7.30 p.m.

Sat., Nov. 18th.—BRISTOL AND WEST OF ENGLAND BRANCH: Grand Hotel, Bristol, "Casting Inspection," H. Williams, 3 p.m.

Institute of Industrial Supervisors

Tues., Nov. 14th.—Technical College, Dudley, Joint Meeting and Brains Trust, with W. Bromwich, Smethwick and Dudley Sections, 7.30 p.m.

Institute of Marine Engineers

Tues., Nov. 14th.—85, Minories, E.C.3, "Some Notes on the Hardening and Heat Treatment of Steel," G. H. Jackson, 5.30 p.m.

Wed., Nov. 15th.—Technical College, Poplar, "The Construction of Marine Boilers," A. P. Monk, 7 p.m.

Institute of Metals

Mon., Nov. 13th.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2, "Symposium on Corrosion Experiences," 6.30 p.m.

Institute of Navigation

Fri., Nov. 17th.—Royal Geographical Society, 1, Kensington Gore, S.W.7, "Surface Navigation in High Latitudes," 5 p.m.

Institute of Petroleum

Wed., Nov. 15th.—Grosvenor Hotel, Chester, "Manufacture of Furnace Carbon Black from Liquid Hydrocarbons at Ellesmere Port," L. W. Cabot and J. W. Edminster, 7.15 p.m.

Institute of Physics

Thurs., Nov. 16th and Fri., Nov. 17th.—26, Portland Place, W.1, Autumn Conference, Nov. 16th, "Basic Theory," Nov. 17th, "Handling of the Arithmetical Problem."

Institute of Welding

Wed., Nov. 15th.—Institution of Civil Engineers, Great George Street, S.W.1, "Welded Bridges and Hangars in Spain," E. Torroja, 6 p.m.

Institution of Civil Engineers

Tues., Nov. 14th.—Great George Street, S.W.1, "Recent Research in Reinforced Concrete and its Application to Design," A. L. L. Baker, 5.30 p.m.

Wed., Nov. 15th.—N.W. ASSOCIATION: Engineers Club, Albert Square, Manchester, "Construction of Sea Forts in Liverpool Bay and the Thames Estuary," J. A. Posford, 6 p.m.

Institution of Electrical Engineers

Mon., Nov. 13th.—N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-on-Tyne, "Discussion of Report on the Education and Training of Electrical Technicians," F. L. Livock, 6.15 p.m.

Tues., Nov. 14th.—MEASUREMENTS AND RADIO SECTIONS: Savoy Place, Victoria Embankment, W.C.2, "The Determination of Time and Frequency," H. M. Smith, "Frequency Standardisation," L. Essen, 5.30 p.m.——SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "The Application of the Gas Turbine Technique to Steam Power," J. F. Field, 7 p.m.——N. MIDLAND CENTRE: British Electricity Authority, 1, Whitehall Road, Leeds, 1, "Design of Power Transformers to Withstand Surges Due to Lighting, with Special Reference to the New Type of Winding," A. T. Chadwick, J. N. Ferguson, D. H. Ryder and G. F. Stern, 6.30 p.m.

Wed., Nov. 15th and Thurs., Nov. 16th.—UTILISATION SECTION: Savoy Place, Victoria Embankment, W.C.2, Conference on "Electricity as an Aid to Productivity," 5.30 p.m.

Fri., Nov. 17th.—N.E. STUDENTS' SECTION: King's College, Newcastle-on-Tyne, "Brazing by Electricity," L. C. Kerr; "Electricity Distribution," A. Jackson, 6.30 p.m.

Mon., Nov. 20th.—N.E. CENTRE, RADIO AND MEASUREMENTS GROUP: Neville Hall, Westgate Road, Newcastle-on-Tyne, "A New Precision A.C. Voltage Stabiliser," G. N. Patchett, 6.15 p.m.——RADIO SECTION: Savoy Place, Victoria Embankment, W.C.2, "The Nervous System as a Communication Network," J. A. V. Bates, 5.30 p.m.

Institution of Engineering Inspection

Wed., Nov. 15th.—DUNDEE BRANCH: School of Economics, Dundee, "Measuring and Inspection," W. Allerby, 7.30 p.m.——N.W. BRANCH: Engineers Club, Albert Square, Manchester, "Economic Quality," L. Hellawell, 7 p.m.

Institution of Heating and Ventilating Engineers

Tues., Nov. 14th.—S.W. BRANCH: R.W.A. School of Architecture, Bristol, "Industrial Air Conditioning in the Textile World," A. L. Longworth, 6.15 p.m.

Wed., Nov. 15th.—LONDON AND DISTRICT ASSOCIATE MEMBERS AND GRADUATES' SECTION: 178–180, Edgware Road, W.2, "The Practical Aspect of Industrial Ventilation," A. C. Mann, 6.30 p.m.

Thurs., Nov. 16th.—BIRMINGHAM AND DISTRICT BRANCH: Imperial Hotel, Birmingham, "High Pressure Hot Water Heating," J. R. Kell, 6.30 p.m.

Institution of Locomotive Engineers

Thurs., Nov. 16th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, Presidential Address, R. A. Riddles, 5.30 p.m.

Institution of Mechanical Engineers

To-day, Nov. 10th.—Storey's Gate, St. James's Park, S.W.1, "Investigations Concerning Flow Conditions in a Centrifugal Pump and Effect of Blade Loading on Head Slip," J. F. Peck, 5.30 p.m.

Tues., Nov. 14th.—AUTOMOBILE DIVISION: Storey's Gate, St. James's Park, S.W.1, "Significant Contributions of the Diesel Research Laboratory," C. G. Rosen, 4.30 p.m.

Fri., Nov. 17th.—Storey's Gate, St. James's Park, S.W.1 "The Supercharging of Internal Combustion Engines," Sir Harry Ricardo, 5.30 p.m.

Institution of Production Engineers

Sat., Nov. 11th.—YORKSHIRE GRADUATE SECTION: Gt. Northern Station Hotel, Leeds, 1, "Refrigeration," E. Hargreaves, 2.30 p.m.

Mon., Nov. 13th.—YORKSHIRE SECTION: Hotel Metropole, King Street, Leeds, 1, "Activities of the Production Engineering Research Association," D. F. Galloway, 7 p.m.

Tues., Nov. 14th.—BIRMINGHAM SECTION: Grand Hotel, Birmingham, "The Role of the Production Engineer in Industry," 7 p.m.——BIRMINGHAM GRADUATE SECTION: James Watt Memorial Institute, Gt. Charles Street, Birmingham, "Steel Production, with Special Reference to Alloy Steel Manufacture," E. Booth, 7 p.m.——LONDON GRADUATE SECTION: 36, Portman Square, W.1, "The Workshop Application of Cutting Tool Theory," H. H. Langshur, 7.15 p.m.——WESTERN SECTION: Grand Hotel, Bristol, "Some Interesting Set-ups on Modern Machine Tools," R. C. Fenton, 7.15 p.m.

Wed., Nov. 15th.—BIRMINGHAM SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Production Engineering Methods Applied to Furniture Manufacture," R. Dolman Bibby, 7 p.m.——EDINBURGH SECTION: North British Station Hotel, Edinburgh, "Costing in Relation to the Production Engineer," W. A. Eastwood, 7.30 p.m.——MANCHESTER GRADUATE SECTION: College of Technology, Sackville Street, Manchester, "Textile Production Engineering," G. A. D. Coughlan, 7.15 p.m.——NORTHERN IRELAND SECTION: Municipal College of Technology, Belfast, "Measurement of Productivity," A. E. Clifford, 7.30 p.m.

Thurs., Nov. 16th.—GLASGOW SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "Latest Developments in Grinding Machines," H. Bottomley, 7.30 p.m.——LONDON SECTION: Royal Empire Society, Northumberland Avenue, W.C.2, "Research in Relation to Production Engineering," D. F. Galloway, 7 p.m.

Fri., Nov. 17th.—E. COUNTIES SECTION: Public Library, Ipswich, "Mechanical Handling," W. J. T. Dimmock, 7.30 p.m.

Institution of Works Managers

Tues., Nov. 14th.—MERSEYSIDE BRANCH: Adelphi Hotel, Liverpool, "The Costing of Engineering Services," H. Mason Bibby, 6.30 p.m.——W. MIDLAND BRANCH: Grand Hotel, Birmingham, "The Role of the Production Engineer in Industry," 7 p.m.——W. YORKSHIRE BRANCH: George Hotel, Huddersfield, "Industrial Management and its Human and Social Implications," A. P. Young, 7.30 p.m.

Junior Institution of Engineers

Fri., Nov. 17th.—39, Victoria Street, S.W.1, "Rubber in Aircraft," F. M. Panzetta, 6.30 p.m.——SHEFFIELD AND DISTRICT SECTION: Grand Hotel, Sheffield, "Some Notes on the Early Days of the Manufacture of Railway Tyres in Great Britain," George Baker, 7.30 p.m.

Manchester Association of Engineers

Fri., Nov. 17th.—Engineers Club, Albert Square, Manchester, "The Use of Mechanical Stokers and Coal Handling Plant for Industrial Boiler Houses," R. W. F. Guy and J. P. Lauder, 6.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Fri., Nov. 17th.—Mining Institute, Newcastle-on-Tyne, "A Preliminary Investigation of the Discrepancies Between the Calculated and Measured Wave-Making of Hull Forms," John R. Shearer, 6.15 p.m.

Reinforced Concrete Association

Wed., Nov. 15th.—Institution of Structural Engineers, 11, Upper Belgrave Street, S.W.1, "Vibrated Concrete," D. A. Stewart, 6 p.m.

Royal Aeronautical Society

Tues., Nov. 14th.—4, Hamilton Place, W.1, "Operational Problems of Public Transport Helicopters," R. H. Whitby, 7 p.m.

Wed., Nov. 15th.—PRESTON BRANCH: Technical College, Corporation Street, Preston, "Physiological Aspects of High Altitude Flying," W. K. Stewart, 7.30 p.m.

Royal Society of Arts

Wed., Nov. 15th.—John Adam Street, Adelphi, W.C.2, "Joseph Paxton and His Buildings," Violet Markham, 2.30 p.m.

Society of Chemical Industry

Thurs., Nov. 16th.—Institution of Structural Engineers, 11, Upper Belgrave Street, S.W.1, "Manufacture of Fletton Bricks," T. G. W. Boxall, 6 p.m.

Stoke-on-Trent Association of Engineers

Sat., Nov. 11th.—Midlands Electricity Board, Back Glebe Street, Stoke, "Steam Generation," W. Carter, 6 p.m.

Women's Engineering Society

Wed., Nov. 15th.—Engineers Club, Albert Square, Manchester, "Some Engineering Aspects of Building a Plant for the Production of Chemicals from Petroleum," H. E. Charlton, 6.30 p.m.

Thurs., Nov. 16th.—LONDON BRANCH: Visit to Kensington Telephone Exchange, 7.30 p.m.

Codes of Practice

The Codes of Practice Committee for Civil Engineering, Public Works and Building and Constructional Work is under the ægis of the Ministry of Works. Codes are issued on behalf of the Committee by the British Standards Institution, 24–28, Victoria Street, London, S.W.1.

CODES OF PRACTICE FOR BUILDINGS: PAINTING NON-FERROUS METALS

THE Council for Codes of Practice has issued for comment Code 231.302, "The Painting of Non-Ferrous Metals," prepared by a Committee convened by the Royal Institute of British Architects.

This code deals with the painting of non-ferrous metals in the forms in which they are most frequently used in buildings, e.g., metal claddings, linings, pipes, cast or extruded sections and fittings. The recommendations given relate chiefly to the methods of preparing the surface of the metals for painting, the types of priming paint suitable for each and the methods of applying the primer.

The code, which should be read in conjunction with Code 231, "Painting," sets out the principles involved in the painting of non-ferrous metals, especially dealing with the need to secure adequate adhesion between the paint and the metal. A section dealing with materials gives a general description for zinc chromate priming paint for aluminium and also a pigmented varnish jointing compound.

Recommendations are given on the preparatory treatment and choice of priming paint for aluminium and its alloys, for aluminium coatings on steel, for magnesium and its alloys, zinc, galvanised and other zinc-coated iron and steel, cadmium-coated steel, copper and copper alloys, lead, terne plate and tin. There are some notes on general precautions to be taken to avoid electrolytic action and condensation of moisture during painting. It is recommended that, in certain circumstances non-ferrous metals should be prepared and primed before delivery to site, and suitable treatments are suggested. The technique of preparing and priming the metal on site is also described and recommendations made as to maintenance.

Appendices include notes on cleansing and preparing aluminium, magnesium and copper and their alloys prior to painting and on durability. The code is in draft form and is subject, before final publication, to amendment in the light of comments, which should be submitted by November 20, 1950. Copies of the code may be obtained from the British Standards Institution, 24/28, Victoria Street, London, S.W.1, price 3s.